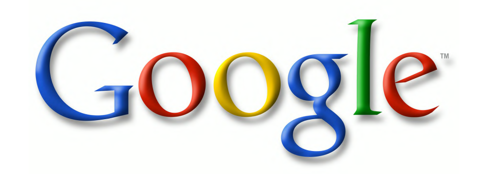
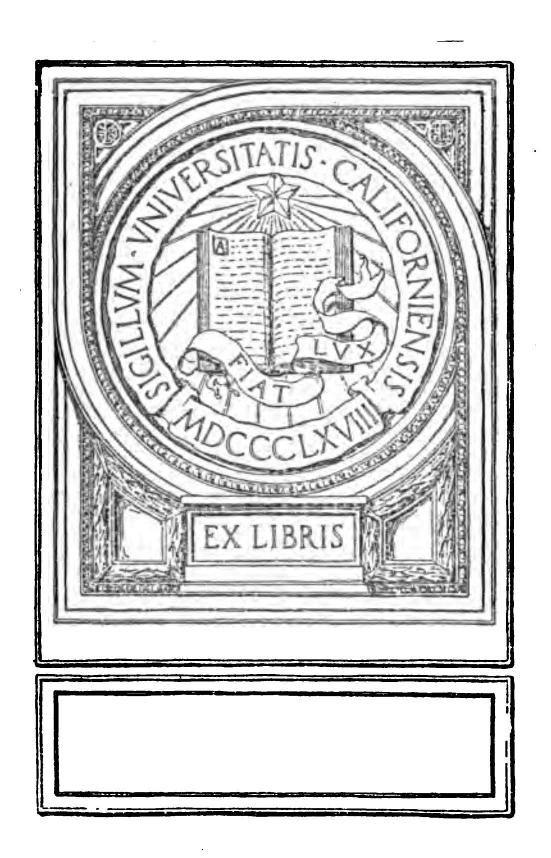
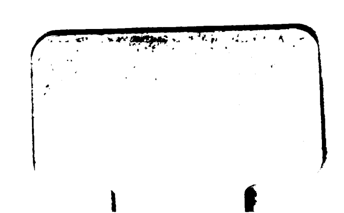



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HEREDITY, DISEASE AND HUMAN EVOLUTION

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BY

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HEREDITY, DISEASE AND HUMAN EVOLUTION

CHAPTER I

PRELIMINARY CONSIDERATIONS

A KNOWLEDGE of the leading peculiarities of disease is evidently an essential preliminary to the consideration of the significance of diseases in the process of human evolution. One who wishes to speak of disease must know what it is. But we do not need, for such an exposition, the strictly scientific groundwork of knowledge possessed by the pathological expert. It will suffice to start with a clear definition as to the essential nature of disease, one which will give us a general understanding of the influence of this process upon the bodily and mental capacity of the individual human being, and in association therewith upon the race as a whole.

What, then, is disease? The answer to this question is so easy, that it might seem almost needless to give an answer at all. For to every one who approaches the question with an open mind it must be obvious at the first glance that disease invariably implies an injury to the patient, in consequence of which his functional capacity is always impaired. Whether the disease is one primarily affecting a single organ merely, or whether the whole body is sympathetically concerned, there results in every case a depression of some bodily or mental function, or of both bodily and mental functions combined. Consequently a diminution in the functional capacity of a single organ, of

several organs, or of all the organs of the body, is the characteristic indication of disease. Disease is the sum-total of the depression in the bodily and mental functions.

This disturbance in the functional activity of the organs is not something existing by itself, for it must obviously be associated with the individual organs; and just as normal function depends upon the normal structure of the parts, so diminution of function arises from changes in the structure or composition of the tissues. These changes, in turn, are conditioned by injurious influences of the environment, such as heat, cold, abnormal nutritive conditions, hunger, poisons, micro-organisms, etc. When such influences affect the organs, these are unable to resist them; the organs are burned, frozen, undergo chemical changes, and so on. In this way there result alterations of extraordinary complexity, greatly diversified according to the regions in which they occur. The noxious influences affect now one portion of the body and now another, inducing abnormal states with which even those without medical experience are familiar when the superficial portions of the body are involved. The layman knows external injuries of various kinds; burns, for instance, since these are so common; boils; ulcers, such as often occur on the legs; such tumours as cancer, etc. None of these changes are compatible with the normal working of the affected parts. It is obvious that an organ injured by any of the influences that have been enumerated cannot continue to do its work as well as before. Hence arises disease. The definition previously given may therefore be somewhat amplified, as follows: disease is the sum-total of the depressions in the functions of our organs which result from alterations in the structure of the parts. This definition appears self-evident to such a degree that the reader may be astonished to learn that formerly many men of science were disposed, as are not a few still disposed to-day, to explain disease as an increase in the vital processes of the body. This view will be discussed in some detail, because its exposition

will render even plainer than before the nature of disease as a depression of functional processes.

How did the converse view come into existence? One of its leading advocates was Paracelsus, the celebrated physician who flourished in the first half of the sixteenth century. He was born at Einsiedeln in Switzerland, lived for a time at Basle, and subsequently practised his profession in Germany and other countries. He died in the year 1541. Paracelsus described disease as an independent entity, invading the human body from without, from the earth, the air, or the stars, taking up its life in the body, and there inducing disturbances. Thus he held that the disease lived its own life in the body. In another form this conception dates from an earlier age. In the neoplatonism of Alexandria the notion of the independent nature of disease plays a great part in the form of the daimons, those spiritual beings intermediate between angel and man, by whose entrance into the body mental disorders, in particular, were supposed to be caused. These daimons were considered to live on independently in the host. This naturally involved the idea that they might leave the sick man, or might be forcibly expelled from his body. This erroneous notion has persisted for fully two thousand years, even if to-day it is found only in comparatively uncivilised regions. Even now we occasionally come across persons who believe themselves to be possessed; and, yet more astonishing, we are still occasionally horrified to learn that priests have had recourse to the practice of exorcism.

As far as science and the cultured section of humanity is concerned, such views have long been abandoned. We now know that diseases are not independent entities, but that they are induced by changes in our own organs. What happens is not that the disease exists first and gives rise to disturbances in the organs. The primary stage is the occurrence of various changes in the organs incompatible with the normal functioning of these, and the functions

are therefore impaired or suspended. The brain of a lunatic is a brain that has undergone changes, and these changes are the cause of the mental disorder. Abnormal changes take place in the valves of the heart, and these give rise to serious disorders in the circulation of the blood. In the person suffering from tubercle, extensive changes have occurred in various organs, and especially in the lungs, impairing the function of breathing until ultimately this can no longer be performed. The breaking of a bone necessarily gives rise to an impairment or to the complete loss of the power of movement in the affected limb. Thus we see that disease is no independent entity, but, on the contrary, that the phenomena of disease in the living body depend upon the occurrence of changes in the organs of the body.

This applies to disturbances of the mind just as much as to disturbances of the body. Function *per se* can never become abnormal. Alike in the normal and in the pathological state, function is inseparably associated with some organ of which it is the function; it does not float in the air, it is not independent. Abnormalities of function can arise only in connexion with abnormal changes in the organ. In the case of the nervous system, and as regards certain mental disorders, it is true that we are accustomed to speak of purely functional disorders without reference to any associated anatomical changes. All that this means, or all that it ought to mean, is that, in the cases in question, we have not yet been able to discover any characteristic changes in brain and spinal cord. No one who is a serious student of the question doubts that in these cases also there are anomalies in the structure of the nervous system upon which the observed mental disturbances are dependent; but these changes are often of so minute a character that it is difficult to demonstrate their existence even with the aid of the microscope.

Anatomical changes underlie all diseases, whether they are spoken of as functional or not. These changes, in their

turn, do not arise spontaneously. As we have already shown, they are evoked by noxious influences which affect the organism and cause changes in its parts. The neoplatonists and Paracelsus may be said, in a strictly literal sense, to have attained long ago to this view, even though their expression of the idea was an altogether indefinite one. The conviction was forced upon them that, especially in the case of diseases of sudden onset, something must have entered the organism from without, but they did not know as yet what this something was, and they were therefore led to assume the existence of independent disease-entities, to which they gave fantastic lineaments. At that date the error was of little consequence. The inner structure of the diseased body was unknown; little or nothing was known as to its differences from the healthy body; it could not occur to any one to make morbid phenomena dependent upon changes in the organs. Not until after the death of Paracelsus did a knowledge of organic changes gradually begin to develop, and more than two centuries elapsed before the Italian, Morgagni, in the year 1761, definitely referred diseases to anatomical alterations. In his famous book, *De sedibus et causis morborum per anatomen indagatis,* he showed that phenomena observed during life correspond to definite changes in the organs.

Among the ancients, even in the absence of knowledge of anatomical conditions, sounder views had prevailed. Four hundred years before the Christian era, Hippocrates referred diseases to a change in the body, to an abnormal composition or admixture of the bodily fluids. In the second century of our era, the celebrated Roman physician Galen adopted like views, and on the strength of his authority, they persisted, though somewhat modified, into recent times. The doctrine in question is known by the name of the humoral pathology, since in this view the essential changes concern the juices or humours of the body. Other physicians of ancient times regarded dis-

eases as dependent upon changes in the fixed parts, upon a condensation or rarefaction of their structure, and this theory has been termed the solidary pathology. The views in question were necessarily incomplete, but they were much nearer to the truth than speculations about daimons and independent disease-entities. We need not further consider the humoral and the solidary pathology. We are rather concerned with the fantastic notions of daimons and of special disease-entities, inasmuch as we wish to show how it came about that diseases were regarded as manifesting an increase in the vital processes. The connexion is not difficult to find. It was supposed that the invading entities would themselves develop greater vitality in the affected organism, and that a further consequence of this would be to stimulate the organs to increased vital activity. These ideas were especially applicable to those suffering from mental disorder, for in such persons there can often be observed a remarkable excitability, and an apparently enormous increase in functional capacity, so that it might well be supposed that the daimons were especially active. More careful consideration would, however, have led to the reflection that it was impossible for these foreign entities, of necessity injurious to the organism, to arouse therein a more exalted life. But the argument was not pursued so far. Attention was concentrated upon the disease-entities that had invaded the body and continued to live there.

These discarded views lead us to conceptions of our own day, which, though greatly modified to correspond with modern ideas, nevertheless return to some extent to this notion of the independence of diseases. When microorganisms were first discovered, there was a tendency at the outset to regard them, not as noxious influences which give rise to changes in the body, but as disease-entities for which the organism serves as a habitat and the effect of whose vigorous proliferation is to arouse in that organism an enhanced vital activity. The microorganisms were to a

large extent identified with the disease, in the belief that when the presence of the former was established, the existence of the latter could be assumed without further inquiry. Since microorganisms are characterised by vigorous proliferation it was considered a natural inference that the disease associated with their presence must be regarded as a condition of enhanced vital activity. At the present day the correct view of the matter is generally understood. Microorganisms are mere noxious disease-producers, just like poison, heat, etc. Their presence induces changes in the organs, and these changes give rise to disease through the depression of function that ensues.

The notion that diseases might signify an intensification of the vital processes was, however, not derived solely from the conception of disease-entities and micro-organisms invading the living body from without. It was held that from the behaviour of the parts of the body it was possible to deduce the truth of such a doctrine. In diseased organs phenomena are of common occurrence which might signify, or in some cases do actually represent, increased functional activity. In the case of inflammation, swelling and redness are, in part, at least, the expression of enhanced vital activity; fever is to some extent due to increased processes of combustion; in valvular disease of the heart which has led to difficulties in the circulation of the blood, the heart itself often undergoes a considerable increase in size. It is obvious that in these cases there has occurred an increase in the activity of certain vital processes, but it would be altogether erroneous to make the changes in question responsible for the occurrence of the diseases. In inflammation we have to do with reaction on the part of the body against the invading noxious influences, and above all against micro-organisms, which are by far the commonest among the exciting causes of inflammation. On the one hand, the noxious influences induce, in the most sensitive organic elements which are the factors of functional activity, certain changes whereby

such activity is depressed; on the other hand, in the more resistant organic elements, they induce the inflammatory processes, which represent a struggle against the excitants of disease, and which must therefore be regarded as essentially favourable to the reacting organism. It is true that the inflammatory reaction may, under certain conditions, have injurious results, but this is not its primary character, being only a secondary result of the process in excess. Even then, its injurious effects do not depend upon the enhancement of vital activity; they depend upon the fact that other parts are interfered with, so that the functions of these are depressed. For example, inflammation of the lung is not injurious *per se*, but because, among other reasons, it depresses the function of breathing.

Again, the increase in the processes of combustion characteristic of fever is not in itself an exciting cause of disease; it becomes so only in an indirect manner, when the increased temperature impairs the functions of certain organs, especially the brain and the heart.

Once more, when the heart undergoes enlargement in consequence of valvular disease, this change is not *per se* disadvantageous. Indeed, the enlargement is favourable to the prolongation of life, because it effects a compensation of the disturbances in the circulation that have resulted from the valvular defect.

Another instance occasionally invoked is that of Graves' disease. It is apt to be assumed that in this disease the functional activity of the thyroid body is notably increased, and that consequently an abnormal amount of the substances formed in this organ is poured into the blood and distributed throughout the body, giving rise to injury and thus inducing the disease. In the first place we may object that the explanation lacks confirmation, that we may well have to do with an altered rather than with an increased activity on the part of the thyroid body, and that this explanation is indeed far more probable. Apart from this criticism, even if it were established that through

the operation of certain external influences the thyroid body were stimulated to enhanced activity, this would not by itself involve the existence of disease. For the disease would arise solely when the increased product of the thyroid body came to exercise an injurious influence upon other organs, and above all when it came to depress the functions of the nervous system. Similar considerations apply to other cases in which processes of increased vital activity are supposed to be related to the occurrence of disease. Such processes induce disease only when they depress the working of some other organ or organs.

Finally it is necessary to refer to one more group of processes. In patients suffering from mental disorder it not infrequently happens that psychical activity becomes extremely vigorous, that there is evidence of enormous mental excitement. It seems at first sight as if the disease took the form of a great increase in the functional activity of the brain. More careful examination soon shows, however, that this view is erroneous. The mental excitement in reality signifies the diminution, and even the complete cessation, of orderly intellectual activity. Despite his exaltation, despite the free flow of his thoughts, the person suffering from mental disorder is incapable of making an orderly use of his mental experiences. His mental work is far below the normal, and indeed it ultimately becomes impossible for him to do any mental work at all. We see, then, that in all the cases in which it was thought that the occurrence of disease might be referred to an increased activity of the vital processes, what has really given rise to the morbid manifestations is a functional injury.

Look at the causation of diseases as we may, we always find that they depend exclusively upon a diminution or a suppression of the function, now of one organ, now of another, and now of several at once.

It results that disease is the sum-total of depressions in the vital functions. In their turn, these depressions depend upon changes in the structure of the tissues.

From this definition of disease and from its establishment by scientific considerations and experiences we may deduce the fact, of which indeed the layman is aware independently of argument, that sick men invariably do less than healthy ones, and that therefore the former are always less valuable than the latter.

These conclusions furnish the basis for our subsequent observations, and we are already in a position to answer the question as to what is the significance of disease in relation to the process of human evolution, by saying that its significance must necessarily be unfavourable. For if the individual human being has his value diminished by disease, the community must also suffer. The injury to the community is greater in proportion to the intensity with which diseases prevail and in proportion to the number cf individuals affected by them. Our next task must be to gain a general idea as to the extension of diseases. They are so extraordinarily common that only a minority of the human race can be regarded as perfectly healthy, and the question may be mooted whether perfectly normal human beings exist. We shall discuss this question first of all. We shall then consider the distribution of diseases, next their manifold consequences, and thereafter the means that may be employed to abolish them or at least to diminish their prevalence. In conclusion, we shall inquire how, in view of the existence of diseases, we may best regulate our lives.

CHAPTER II

THE FREQUENCY OF DISEASES AND THE LIMITS OF HEALTH

If we were to estimate the frequency of disease from our daily experience in intercourse with those engaged in our own or in other occupations, we might be led to believe that most people enjoy good health. A large majority of persons in active life believe themselves to be healthy, and indeed are so, if by health we are to understand a condition in which people feel themselves free from the disturbances we are accustomed to notice in those who in ordinary parlance are said to be ill, or from the disturbances which are the sequels of an illness.

When, however, we take into account the fact that even among those who remain actively at work many are suffering from morbid conditions, and that many others are by such conditions forced to relinquish their work, and when we look outside the circle of those whom we encounter while going about our ordinary avocations, to consider people in family life, and those in hospitals, infirmaries, prisons, etc., we gain a very different impression. This new impression is greatly strengthened if we take into account, not merely those diseases, passing by one name or another, which usually involve greater or less danger to life, but when our notion of health becomes one involving more extensive demands; if, that is to say, we regard as imperfectly healthy all those persons who in one respect or another, it may be mental or it may be physical, fall so far behind the average that they are affected by injurious influences which others are able easily to withstand. In one aspect or another, their development

is so defective that the weak point gives way when put to a high test. If we take this as our notion of health, then we have to add to diseases as ordinarily understood all those lesser or greater divergences from the norm which are incompatible with perfect health, all constitutional and congenital deficiencies, general bodily weakness, defective development of the lungs, the heart, the sexual organs, imperfect mental development, numerous psychical disturbances on the margin of developed mental disorder which have been so vividly described by Pelman in his book on *Borderland Mental States,*[1] nervousness, many malformations not directly dangerous to life, poorness of blood, short-sightedness, colour-blindness, obesity, and others. In the narrower sense of the term disease, these for the most part are not diseases; but if we take a diminution of functional capacity to be characteristic of the diseased state, we must recognise that the disturbances we have named all manifest this characteristic. Human beings thus affected are less useful than others; they are less efficient than these, if not altogether inefficient; and they tend in many ways to react to the disadvantage of their fellows.

To all this has to be superadded the experience gained in the post-mortem room. In autopsies we note with astonishing frequency that, apart from the diseases which have actually caused death, human beings are not perfectly healthy, that they often show divergences from normal structure, of which they were completely unaware, which ordinarily do no harm, but in certain circumstances might have proved disadvantageous. We also find on the post-mortem table vestiges of all sorts of earlier illnesses which, although their presence was not during life associated with any characteristic symptoms, yet cannot fail to have exercised an influence upon the vital functions (pleural adhesions, which are quite extraordinarily frequent, pericardial adhesions, changes in the arteries, in the valves of the

[1] *Die psychischen Grenzzustände.*

heart, in the heart-muscle, etc.). Most conspicuous among these and most important are tuberculous processes. These are sometimes recent, and have attracted no attention during life; while we often find lesions of much earlier date, which seem to have altogether run their course and which, even if life had persisted, could not have given rise to any further marked symptoms of disease. Such changes are especially common in the bronchial lymphatic glands, situated in the thorax close to the larger ramifications of the bronchi. In their oldest forms they appear as calcareous nodules, whilst those of more recent date are the so-called caseous masses, foci of inflammatory matter killed by the tubercle bacilli. As a rule, in this form, they are no longer dangerous, but we know that they still contain living bacilli. The possibility is therefore ever present that under certain conditions the bacilli may once more begin to multiply, and may lead to a renewed spread of the disease. In any case, their presence is the proof of the previous existence of a circumscribed tuberculous process which underwent arrest without causing extensive damage. It is of especial interest to ascertain the frequency of these vestiges of past tuberculosis. Many investigations have been made on this point, and their results are somewhat discrepant. One investigator reports that he has found such foci on post-mortem examination in the bodies of 95 per cent. of all adults, whereas other observers report no more than 60 per cent., and express the opinion that even this high proportion finds its explanation in the fact that the bodies in question are those of hospital patients, persons belonging to the less well-to-do classes, who suffer more frequently from tuberculosis than those in easy circumstances. Even if this objection could be sustained, the general total would not be markedly affected. The classes that suffer especially from tuberculosis are far more numerous, and if as many as 95 per cent. among these suffer or have suffered from tuberculosis, the general incidence of the disease is not greatly influenced by the lesser

liability of the well-to-do. After all, we are not much concerned about a few per cent. one way or the other. Even if no more than 90 or 85 per cent. of the bodies of adults display tuberculous lesions (and in my personal experience the lower figure, at least, is always attained), the percentage remains an extraordinarily high one. We are in a position to assert that the large majority of human beings have had their bodies invaded by tubercle bacilli, and that the result of this invasion has been an illness of greater or less intensity. If we take into account what was said above about other morbid states of more or less frequent occurrence, we are led to the conclusion that it will not be easy to find a human being perfectly healthy in every respect.

This conclusion, certainly, can not be applied to the subjective feelings of human beings. Many of those affected with trifling anomalies feel perfectly well and are efficient enough. The question of chief interest we have to answer is, how many persons there are who are really ill owing to the existence of one or more of the abnormal conditions enumerated above—how many, that is to say, suffer, in consequence, from a real depression of functional capacity. The estimate is naturally difficult to effect, for there exist all possible transitional lesser stages of disease between the severe forms and the states regarded as representing perfect health. All that we are able to do is to count the number of sick persons who receive medical treatment. But however difficult it may be to obtain trustworthy data, we possess one extremely useful source of information, that furnished by the records of fitness or unfitness for military service. In Germany, about one half of the men legally liable for military service are rejected as unfit. It follows that of a hundred men, fifty are either ill or not perfectly healthy. There can be no doubt that an examination of women would give similar results. From this outlook we see that only one half of all human beings twenty years of age can be regarded as healthy. In fact, however, this

estimate is too favourable, for not all the men accepted as fit for service actually prove to be so. From 4 to 5 per cent. of those enrolled are subsequently discharged as unfit, and of those who remain after this sifting by no means all can be considered in perfect health. Many deficiencies manifest themselves only at a later date, when the time comes to earn a livelihood, to enter into competition, to take part in the struggle for existence. It is therefore beyond dispute that in the succeeding decades of life, in which the human being has for the first time to meet the most extensive claims, in which it becomes necessary for him to demonstrate his functional capacity on behalf of himself and his fellows, the number of invalids and of those unable adequately to meet the claims made upon their energies greatly increases. It is only at this period of life that many diseases dependent upon inheritance, such as gout, diabetes, and mental disorders, first manifest themselves; others, like tuberculosis, now make disastrous progress. Now appear also numerous chronic and incurable diseases, those which cause permanent and increasing injury, such as inflammations of the kidney, cirrhosis of the liver, various cardiac defects, and other disturbances of the activity of the heart, diseases of the blood-vessels, with their manifold evil consequences, cancerous and other tumours, syphilis, the consequences of alcoholism, of over-exertion, etc.

The morbid conditions just enumerated, when they have once manifested themselves, render the sufferer useless or impair his value for the rest of life—gout, for instance, diabetes, contracting kidney, diseases of the blood-vessels, mental disorder, etc. Such diseases, whether present from birth or developing subsequently in consequence of an inherited tendency, whether like tuberculosis they may arise with or without the existence of predisposition, or whether they are induced in individuals previously healthy through the operation of noxious influences in the environment—such diseases, once they have appeared, are either

incurable or but partially curable. They give rise to permanent injury.

We have no trustworthy data as to the proportion of persons thus diseased or diminished in value during those middle decades of life which are the most important to humanity. But there can be no doubt whatever that far more than half, that at least three-fourths, of all human beings at this period of life must be said to fail to attain to the standard of perfect health.

We have still to take into account all the transient newly acquired diseases which lay people up for a time, terminating in recovery or in death, or leaving behind them all sorts of disastrous consequences and perhaps permanent invalidism. Even though the majority of such illnesses, such as inflammations of the lung, catarrhs, typhoid, physical injuries, wound infections, etc., commonly leave no permanent impairment of health, the interruption to the working powers of the patient, with its inevitable reactions upon those dependent upon him and on wider circles, is a very serious matter, and often involves permanent injury to the course of life. Such illnesses are extraordinarily numerous. It is impossible to give precise figures, for no attempt has hitherto been made to ascertain how frequently the individual suffers from these transient affections. But it is universally known that we seldom meet any one whose functional capacity has never been impaired by illness. The majority of elderly people have been ill very often.

All that has been said refers only to the most important period of life, the middle decades, in which the physical powers are at their best. But before this period is attained death has already reaped a rich harvest. Every one knows that the mortality of children during the first year of life, due above all to intestinal disorders dependent upon errors of nutrition and lack of proper care, but due also to tuberculosis, syphilis, etc., is enormous and a scandal to our civilisation. We shall return to this matter later.

After the first year of life, large numbers of children succumb to the common infectious diseases, diphtheria, measles, scarlatina, whooping-cough, and tuberculosis. This involves a great increase in the percentage of illness.

On the other hand, we have to bear in mind that after middle age diseases become especially common, increasing in frequency as years advance. This applies, first of all, to chronic and generally incurable morbid states. So common do they become that the enormous majority of old persons display, not merely trifling disturbances, but developed morbid states, even if these are not always severe. As age advances, vascular changes become especially common, the so-called calcareous degeneration of the arteries, with all the dangers it entails for the brain, the heart, and other organs and parts of the body; pathological conditions of the bones and joints, impairing the powers of movement; cancer in all its forms.

The consequences of the diseases of old age, especially those that run a chronic course, are often difficult to distinguish from such as are the direct result of old age *per se.* In both cases we have to do with a depression of functional capacity. Hence it has been maintained that old age must itself be regarded as a disease, as a consequence, above all, of defective circulation of the blood resulting from alterations in the blood-vessels. This view is erroneous. At the post-mortem examination of the body of the oldest man or woman we do not necessarily find any organic changes of which we can speak as morbid, apart from the acute disease, inflammation of the lung, for instance, from which the patient has died. What we always do find in such cases is a diminution in size of all the organs and of the cells of which they are composed, and, as age advances, we note with increasing frequency that the cells are stained yellow and brown. But these are phenomena attaching to the normal course of life; that is to say, they are physiological in character, but would ultimately extinguish life if it were not brought to an end by some acute

process. It is true that Metschnikoff contends that these changes, which are especially marked in the heart and the brain, are morbid in character, and that they must be referred to a process of auto-intoxication derived from the large intestine, filled with fæces and micro-organisms. This, however, is impossible. The large intestine, like every other organ, so long as it functions normally can never be a source of injury to the rest of the body. In old age, of course, it may undergo pathological changes, and may then, like any other diseased organ, exercise an injurious influence upon the body. This has no bearing upon the changes of old age. These appear by rule, whilst in old age the large intestine is diseased only by exception. The appearance of senility must rather be referred to the fact that the cells of the various organs gradually lose their vital capacity because their prolonged activities ultimately induce changes incompatible with the proper performance of their functions. In the cells of the brain, the heart, and other organs, there occurs an accumulation of minute yellow granules, which must be regarded as products of tissue change, their presence impairing the activity of the cells. It is upon these granules that the above-mentioned brownish tint of the organs depends. This matter will not be further discussed here, since it does not concern morbid processes in the strict sense of the term, but the terminal results of physiological processes. Those interested in the question may refer to my own earlier writings, the monograph, *Der Tod aus Altersschwäche,*[1] Bonn, 1908, and *Altwerden und Jungbleiben,*[2] *Deutsche Revue,* April, 1912.

None the less, if old age cannot, strictly speaking, be regarded as a morbid state, it is naturally not to be described as one of perfect health. Invariably, the old man or woman is less functionally efficient, often much less, thus displaying the criterion that is characteristic of every pathological state.

[1] *Death from Old-Age-Weakness.*
[2] *Growing Old and Keeping Young.*

If we take a general view of the considerations adduced in this chapter as to the frequency of diseases, we are led to conclude that, during the middle decades of life, during the period, that is, mainly characterised by the manifestation of those functional activities of chief importance to the evolution of humanity, more than half of all persons lack sufficient health to enable them to meet all demands; that in the case of the remainder, of those ordinarily regarded as healthy, the majority are also affected with comparatively trifling morbid changes which do not impair functional activity, and whose existence is apt to be demonstrated only on post-mortem examination; that in advanced age the very large majority of mankind suffers either from a chronic disease or from minor disturbances incompatible with perfect health; that hardly any one escapes attacks of acute or curable illness, and that most people suffer from such attacks several or many times. Finally we have seen that in youth, on the one hand, the frequency of illness is especially great, and in old age, on the other hand, it is so extremely high that old men and women suffer, with few exceptions, from definite morbid conditions, altogether apart from the fact that in any case their functional capacity is always much less than when they were younger. It results that only that minority of human beings who exhibit during their daily life no more than trifling and barely perceptible morbid changes, appearing otherwise healthy, are in a position to devote the whole of their powers to the evolution of humanity, and that the activity even of these is occasionally interrupted by the incidence of acute diseases. All other persons have their functional activities permanently limited or completely suspended by the pathological conditions with which they are affected.

The considerations hitherto adduced by no means exhaust the subject of the inadequate functional capacity of our race. We have further to ask whether those of whom we may speak as healthy in daily life all really attain the

highest degree of functional capacity which might be attained by human beings normal in every respect, whether they adequately fulfil all the demands made upon them alike bodily and mental. The attempt to answer this question induces doubts which will be discussed in the following chapter.

CHAPTER III

DO NORMAL HUMAN BEINGS EXIST?

We pointed out in the last chapter that there are many persons who cannot be said to be ill in the strict sense of the term, but whose value is so much below par that they readily give way in one direction or another when extensive demands are made upon their powers, are injured thereby, or become actually ill. It is obvious that the conditions with which such persons are affected do not constitute a sharply circumscribed group, clearly distinguished alike from states of actual disease and from states of perfect health. All possible transitional stages exist between such conditions and disease on the one hand, and health on the other. We meet with many cases in which persons stand on the boundary line of disease, and when the question of classification arises, whether they are placed upon one side or the other depends upon the observer's preference for a stricter or more lenient view. Those, again, who occupy the domain of the healthy, differ widely among themselves. They diverge more or less extensively from an ideal state of health, of which admittedly we can frame no more than a theoretical conception. This ideal state is what we speak of as normal, and we have now to ask ourselves if and how it can be defined, and whether we may expect to encounter it in the concrete.

When can we denote a human being as normal? It is evident that in this connexion we can think only of healthy individuals, only of such as are free from constitutional or chronic disease, and who at the time of investigation are also free from acute affections and their consequences.

Such individuals can further be regarded as normal in the fullest sense, only when all their organs are soundly constructed on lines which generally accepted scientific experience leads us to recognise as physiological, when all these organs function as we know they ought to function, when they work together with perfect harmony, when not one errs either by excess or by defect in point of functional activity from the mean degree which experience leads us to recognise as proper. A human being who meets these demands can be spoken of as normal, but it is evident that a sharp delimitation of this ideally conceived state is impossible. The state is one separated by innumerable intermediate gradations from states that can no longer be regarded as normal.

Does such a theoretically conceivable normal state exist? As regards isolated functions, such as cardiac activity, or memory, the question is comparatively easy to answer. We often find ourselves able to speak of these special aspects of the individual as normal. It is altogether different, however, when we consider all the functions at once, and when we examine any one in order to ascertain whether all these are alike normal. When we do this we are soon forced to recognise that in this sense the normal human being does not exist. First of all, a great many persons exhibit a general depression of their mental functions. It is clear that however exuberant their health may seem to be, such persons cannot be regarded as normal. If we were to admit this, we should also have to admit those persons to be normal whose mental life is in good order, but who suffer from considerable general bodily weakness.

In all other persons we find a defective development, now of one function, now of another. This is especially noteworthy in the intellectual sphere. Sometimes one capacity is defective, sometimes another, sometimes several are defective at once. Many persons are competent for some particular occupation, while incompetent for the performance of all the other duties of life; their development

is markedly one-sided. Such a condition is incompatible with our definition of normality. On the way to such extreme instances we find numerous transitional stages. Many persons are functionally competent outside their own narrow sphere, and exhibit an intelligent understanding of other questions. The more they display such general aptitudes, the more nearly do they approximate to the ideal state; but they never attain it, for one side will always be found comparatively overdeveloped.

The majority diverge considerably from the normal. Left entirely to themselves, and lacking the complementary assistance of their fellow men, likewise one-sided, but in other directions, they would be unable to carry on their lives satisfactorily—they are not of standard value.

It may be objected that it is obvious that persons in whom certain functions are under-developed are not perfectly normal. There exist, however, in addition numerous individuals whose divergence from the norm depends upon the fact that this or that capacity is developed to an exceptional degree. In these the harmony of development is disturbed, and yet we cannot refuse to them the quality of normality. A functional capacity developed to excess must be spoken of as super-normal, and not as sub-normal.

We shall, however, approach this problem differently according as our attention is especially directed to the well-developed function itself or to the condition of the rest of the organism. It is evident that an increase in some particular capacity cannot *per se* detract from normality. One with exceptionally powerful muscular development, one with exceptional musical faculty or some other gift, is not therefore necessarily abnormal. But how often do we observe that an individual thus distinguished remains below average in his other functional capacities, that these fail to reach the normal level, so that a complete harmony of all the faculties is lacking. When one function is endowed to excess, the others suffer from defect. Thus certain exceptionally muscular men, such as athletes with

a one-sided development, can by no means be regarded as normal. They are apt to be clumsy in their movements, unfitted for the more delicate physical manipulations, and in them, as a result of long continued over exertion, the heart gives out sooner than that of an ordinary man. Again, those intellectually distinguished in some particular capacity are often less well-developed, and perhaps altogether inefficient, in other respects; not infrequently they fail in face of the practical demands of life, and sometimes their physical development is backward although they cannot be said to be diseased.

Thus there exists an enormous number of human beings whom we are forced to regard as not completely normal, as inharmoniously developed, although many of these may be of the greatest use to humanity precisely on account of their one-sided aptitudes.

Nor have we to consider merely the case of isolated individuals whose capacities are not perfectly normal. There exist also whole groups in whom normality is lacking. First of all must be mentioned the lower races, which remain at a level long surpassed by the higher races, and lag far behind these in functional capacity. Their whole mental constitution is of inferior value, and in various respects they manifest a one-sided mental development. They will not be spoken of as diseased, they must be termed healthy, but we cannot describe them as normal in the sense here given to the term.

Further, within the limits of a single race, even the highest, there are whole groups of human beings who cannot be regarded as perfectly normal. The members of these groups exhibit an incapacity for the development of one faculty or of another; or satisfactory development is limited to some particular direction. Entire classes exist whose mental life is altogether inferior in quality to that of other classes, persons, for example, whose capacity attains the normal in physical respects only, while their mental powers remain inadequate. For example, the men-

tal life of most country folk is as a rule altogether defective. If they possess adequate inborn aptitudes in this respect, their faculties are atrophied from lack of proper exercise. Similar conditions prevail in the case of a large proportion of manual workers. The monotony of their daily occupation, which makes demands merely upon their physical capacities, leads to an atrophy of all their other aptitudes, or at any rate keeps these at a very low level. It is impossible to describe as a normal human being one who, earning his daily bread by arduous manual labour, has never found time to develop his other capacities, who for this reason feels no need, when he has slept and refreshed his body, for any other occupation and for the perfecting of his own development. Now such consequences of the one-sided cultivation of faculty are common to a greater or less extent to all occupations. To comparatively few only, to those of manifold endowments and independent position, is it granted to look over the high walls by which their working domain is surrounded and to win for themselves something of all that exists without. This is true, above all, of mental development. Our education is altogether one-sided, not only as far as concerns preparation for a definite profession, but often even earlier, in our schools. This one-sidedness inevitably becomes still more marked when the goal has been attained and when the man is yoked to his professional task for the rest of his life. Hence arises the lack of interest in one group for another and for the community at large; hence the lack of mutual understanding, for those of one profession know nothing or very little of those of another; hence also distorted and regrettable judgments and the supervaluation of one profession over another. It is hardly necessary to give examples, but the reader may think how one-sided are the great majority of philologists, lawyers, army officers, men of learning, officials, etc. Such one-sided development is incompatible with the normal state. We have also to remember that innumerable human

beings are shut out from marriage and are thereby excluded from one of the most important sides of life with its manifold relationships and duties. Look again at the various orthodox creeds. These impose on all their adherents certain strict dogmatic views, which keep them remote from numerous problems and activities of human life, and which are even in open hostility with many aspects of life; those who accept these limitations must become extremely one-sided, regarding the world from a narrow outlook, admitting that science has a right to exist only in so far as it harmonises with the preconceptions of dogma, this involving mental bias and prejudice. It may be objected that no one can approach the study of science itself altogether without preconceptions. In a general sense this is true; but the genuine scientific investigator has no dogmatic shackles, and is ready at any time to abandon his preconceptions in favour of more enlightened views. In this sense he may be said to be free from his own preconceptions, to which, on the other hand, the dogmatist is unconditionally bound.

Thus the various classes of mankind lack harmonious development; they are more or less one-sided; they are abnormal.

Nor must we forget that entire races may exhibit an injurious one-sidedness. Think of jingoism, of racial fanaticism, of the one-sided education of children which devotes them to mental work while neglecting physical culture, and the converse error, the over-valuation of sport, whereby national progress is hindered.

Thus wherever we look we observe a disadvantageous one-sidedness of capacities and of cultivation, a lack of harmonious development. The majority of human beings cannot be regarded as normal; a few only can claim to come within the limits of this conception, and none can be said to correspond to it perfectly. One person fails to be normal because he falls below the average to an injurious degree in some or in all capacities; another, because

his mode of life and the necessities of the struggle for existence involve the atrophy of one, several, or all his faculties; a third, because the development of some one capacity in very great excess has left all the other capacities defective.

Is another and a better state than this attainable by the human race? May it not be asked whether it is conceivable that all individuals might be born with faculties susceptible of full development, or that the high or maximum cultivation of one faculty need not necessarily be accompanied by defective cultivation of the others? Are we not forced to answer these questions with a direct negative, and to maintain, in especial, that the evolution of the human race is impossible in the absence of one-sidedness on the part of individual members of that race? For the conditions of life do not permit of a harmonious and equable development. Yet this, we are told, is of no consequence because human beings have to display effective functional capacity, not along many lines, but by means of the highest possible development of isolated faculties. All this is not untrue, and yet it is true only to a certain degree. It is unquestionable that an all-sided functional capacity is excluded from possibility, that one-sidedness will always persist, and that in the near future it will certainly increase. But it is erroneous to suppose that this one-sidedness will necessarily for ever be so extreme as it is to-day, so extreme that the other aptitudes atrophy in consequence, and that the individual becomes one-sided in an exclusive sense. To this question I shall return. At the moment my concern is merely to establish the fact that excessive one-sidedness exists, and to indicate that all persons thus affected, the large majority, that is to say, must be described as abnormal precisely because they exhibit this excessive one-sidedness. We have, however, to recognise that a certain degree of one-sidedness is essential to the evolution of the human race. Those individuals only who are fully cultivated in some particular direction

can attain therein to the highest functional capacity such as is necessary for the advance of the human race as a whole. Hence the individual must always be one-sided, for the highest possible perfection of one faculty cannot fail to involve defects in the others. Even the man of genius, who receives our ungrudging admiration and who assists to so notable a degree in the advance of our race, is poorly developed in other directions than those characteristic of his particular endowments. In a great many cases, indeed, this is not obvious, or we overlook it because we are interested only in observing the healthy side, but there are geniuses not a few in whom the deficiency of their other qualities, a deficiency which may be accentuated even to the point of disease, is plainly disadvantageous. Genius and madness have been spoken of as akin, and the question of this relationship will receive consideration later. For the moment it suffices to point out that the individual in whom the one-sided development of a particular faculty is associated with inadequate cultivation along other lines, will often suffer if, because of these deficiencies, he is unable to play his part fully in the general life. Under certain conditions the qualities that are useful to humanity may become a curse to their individual possessor. It is only when the other faculties are also cultivated to the fullest possible degree that the one-sided cultivation of the pre-eminent faculty will not be injurious to the individual.

At the present day, however, an altogether abnormal one-sidedness commonly prevails. The great majority of human beings are imprisoned in a narrow circle of activities, and are thereby excluded from the many-sidedness of life. With comparatively few exceptions individuals receive a one-sided education from birth onwards; one-sided they live and work, and one-sided they remain till death. For them the fulness of life in its endless manifoldness has no existence. The peasant, the labourer, the factory hand, the small trader, and many of those commonly sup-

posed to belong to the cultured classes, in so far as they make no attempt to enlarge their capacities, know nothing of life beyond a small and narrow circle, and none of them, in view of the widespread atrophy which may go so far as complete suppression of other branches of activity, can be regarded as normal human beings.

Wherein lies the explanation of these lamentable conditions? In part, unquestionably, in the environing circumstances in which most of us live. The struggle for daily bread, the dependent position into which most people were born, enforces upon them a one-sided cultivation, for thus only are they able to secure the means of life. Their lives run on in an almost unbroken grey monotony, and they are excluded from participation in what brings happiness and enjoyment to others. Human society, which is satisfied if the individual is able merely to live, provides no institutions to lift its members above the level of this everyday uniformity.

The needs for the struggle for daily bread are not, however, the only cause of the trouble. As we have already pointed out, and as we wish to emphasise once more, education plays an important part. It is almost always undertaken by persons, parents and teachers, who have themselves suffered from a one-sided cultivation. School should provide, by means of a many-sided instruction, a certain degree of general culture. In one way or another, however, the school provides for some definite direction of cultivation. In so far as its influence is many-sided, this influence is exerted for too short a time, and is not nearly as extensive as it ought to be. Quite early in life the one-sided cultivation begins, as a preparation for some particular calling. Such special cultivation is doubtless essential; but too little attention is given, and from lack of time inevitably so, to an enlargement of the faculties by instruction in other directions. After leaving school, the individual soon forgets all that has no bearing on

his specialty and thenceforward, in the case of a large majority, the outlook becomes ever narrower.

We have now to ask, if we could suppose the needs of the struggle for existence not to involve this one-sided development, whether all persons would themselves exhibit the desire and the possibility to be other than one-sided. We are unfortunately compelled to answer this question in the negative. The majority of human beings have to-day neither impulse nor capacity for all-sided development. They are subject to the limitations of their inherited organisation, whereby the individual activities are predetermined to be one-sided. Congenital predisposition is the foundation of the individual's whole development. It is possible, and this is a point to which we shall return, to cultivate an inborn quality by exercise or to weaken it by neglect; but it is altogether impossible to call into existence a quality whose elements are lacking or to cultivate to a useful extent one whose elements pre-exist only to a minimal degree. The inherited aptitudes of individuals are extraordinarily diverse; some are good, some moderate, some altogether defective. Upon these differences depends the direction in which the individual becomes active; upon these depends the lack of capacity or impulse for all-sided or even many-sided development; upon these, also, depend the indolence and the egotism which lead to the neglect of all other considerations, and to the exclusive cultivation of those faculties which promote advance in the chosen occupation. Primary defects in inherited aptitudes thus give rise to a deplorable one-sidedness which persists throughout life.

The needs of life, then, education, and inherited predispositions, render readily comprehensible the existence of the one-sidedness of which we have to complain. We recognise why it exists, and why under existing conditions its existence is inevitable. But it is our natural desire to mitigate it as far as may be, and to have justice done to the other sides. In the exaggerated form in which it

now prevails, this one-sidedness is extremely injurious. It frequently turns life into a waste, or at least has as its result that most persons are dissatisfied and fail to make the best use of life. The individual's one-sidedness is injurious also to his fellow human beings. Consider, for example, that the adherents of some particular religious creed not infrequently despise, contend with, and persecute, those who differ from them in opinion; that a one-sided lawyer sometimes regards an accused person, not as a human being, but simply as an object for the application of the laws, and by so doing arrives at false conclusions; that the one-sided politician pursues politics from interested motives; that morality-fanatics empty the child out with the bath; that one-sided advocates of the emancipation of women ignore woman's most important function, that of motherhood, thereby endangering the future of the race, and being led to adopt such methods as those of the militant suffragettes, thus derogating from their own human worth; and so on. Not even those who are actually diseased breed mischief so extensively as do such one-sided persons, especially in view of the fact that in the former case we can interfere to counteract the trouble, whilst in the latter case will or opportunity to do this is often lacking.

Even in their own sphere, extremely one-sided persons must often be regarded as not completely normal. Such persons are in many respects of inferior value, and we cannot draw any sharp distinction between them and those who are actually diseased. We need merely recall that religious one-sidedness often degenerates into mental disorder, as in the flagellants and all others who torture themselves from motives of misconceived piety. We see the same thing in the case of the dancing manias, in the care of witches and their persecutors, in dervishes, in the self-mutilators of the Skoptsy sect, in cases of suicide from religious motives, etc. For this reason in our subsequent argument we shall have to consider diseased persons

and those whose value is below par from the same point of view.

This problem as to the existence of normal human beings has further to be considered in relation to one particular side of mental life, namely, that which involves the moral or ethical aspect. It is obvious from the first that in this respect individuals exhibit extreme diversity. When, however, we go on to ask how many persons can be regarded as morally normal, we have first to come to an understanding as to what we mean by ethical. Speaking generally, it is true that a common understanding may be said to exist upon this point. As regards some particular action or conception, no doubt need in most cases arise as to whether it is to be called moral or immoral. But we need a brief and precise definition of what is to be considered ethical from the standpoint of natural science. We may best start from the notion of what is immoral. Much that receives this name really belongs to the sphere of disease. This applies to criminal acts, and to the acts of many individuals whose mental capacity is below par, and in whom the power of distinguishing between what is moral and immoral is either absent or altogether insufficient. Here we are concerned with diseased persons, but there is no sharp boundary line between this pathological sphere and the sphere of what is normal in the sense of our definition. Many tendencies that are not normal rank as immoral, such as excessive egoism, oppression of the weak, the promotion of incompetence, the persecution of others on account of their belief, marked untrustworthiness, and so on. None of these characteristics are present in the normal human being. It follows that everything which is immoral is either diseased, or at least below par value, abnormal. Conversely we must say that a normal man cannot be otherwise than moral. In such a one all the qualities exist in perfect mutual harmony, and in perfect harmony also with nature, of which his fellow-men form a part. In him no one peculiarity is developed,

either quantitatively or qualitatively, in such a way as to be harmful to his own other endowments or injurious to those of his fellows. Thus all is moral which a completely normal human being thinks and does. We must also regard as moral everything that is adapted to promote the normal bodily and mental constitution of human beings. Immoral, on the other hand, is everything which proceeds from the thoughts and actions that are the outcome of morbid and abnormal behaviour on the part of human beings, and everything that tends to be injurious to the normal physical and mental constitution.

The sole and exclusive measure of our conception of moral and immoral is the normal human being.

How large is the number of individuals whom, in the light of these considerations, we may describe as completely moral? Every one who has contemplated himself and his fellows must admit that the number is certainly not very large. It is true that we do not get very far by purely objective observation, which is much less helpful in this regard than introspection. A great deal is hidden from objective observation, and requires to be examined subjectively. We go on to ask, then, how many individuals are there who would venture to describe themselves as moral personalities in every respect? This is a question we neither will nor can answer, and we leave it to the individual to make his own estimate. If, however, we are forced to conclude that only a few persons can be regarded as moral in the strictest sense of the term, we have in this case also, when we wish to estimate the significance of ethical endowments in the evolution of humanity, to take into account the existence of gradations. There are certainly numerous individuals who for practical purposes and in relation to the tasks of daily life may be described as moral.

Summing up all these considerations, in our answer to the question as to the number of perfectly normal human beings, when we add to man's defective intellectual endow-

ment his more or less developed and disadvantageous one-sidedness, and his possible ethical deficiencies, the general result is not very favourable. These various defects are unequally distributed, and not in such a manner that they appear all together in one individual while another is quite free from them. We find rather that one person is defective in this direction, another in that; that one fails in one point, another in many points. Intellectual and moral qualities are by no means necessarily associated, some persons being distinguished for the former and others for the latter. Very intelligent men may be extremely immoral, and those who are highly ethical may exhibit a very low level of intelligence. Thus the very large majority are abnormal in one direction or another, and if we use our terms strictly we need not hesitate to say that completely normal human beings do not exist. It must be admitted that the significance of this statement in relation to the evolution of our race is less great than the plain sense of the terms might seem to imply. There are many whose divergences from the normal are so trifling as to do very little harm. Yet in the case of the large majority there exists incapacity for the performance of some or all of the tasks which the community has to undertake.

If we now reconsider what was said in the previous chapter about the diffusion of diseased states, and in the present chapter about the lack of normality, we must admit that there is on one side of the account a quantity of deficient values many times greater than the counterbalancing sum of normal conduct, and that thereby the evolution of the human race has always been hindered and will be hindered in the future. In part we have to do with purely physical disturbances which impair the individual's powers of co-operation with his fellows; in part, and above all, we have to do with mental anomalies dependent upon anatomical changes in the central nervous system. All these inferiorities in value are not of importance solely to the affected individual, for their influence extends far more

widely. His dependents and his nearer and remoter associates, his contemporaries, and posterity, are injuriously affected in manifold ways. These have to be considered in subsequent chapters.

CHAPTER IV

THE SIGNIFICANCE OF DISEASES TO INDIVIDUAL MEN AND IN RELATION TO THE FREEDOM OF THE WILL

THE sick man is less functionally capable than the healthy. This is shown by our previous exposition, and the chief consequences of disease to the individual have already been pointed out. But more remains to be said.

Diminution in functional capacity is naturally most obvious in serious illness, and especially in the case of those illnesses whose onset is sudden, so that the contrast between the condition of health and that of disease is conspicuous. Those suffering from acute pneumonia, diphtheria, typhoid, meningitis, etc., are completely unfitted for work. But the degree to which the working powers are impaired by far less serious affections, such as toothache, headache, boils, or physical injury, is known to us all from personal experience.

The disadvantageous influence of an illness is obviously proportional to its duration. Pulmonary tuberculosis, diabetes, gout, and other illnesses which last for decades, cause permanent impairment of the sufferers' powers. Such permanent impairment is above all the outcome of congenital diseases, and especially of those which affect the nervous system. The manifold psychical disturbances associated with the last-named not infrequently involve a permanent depression in value throughout life, and may even unfit the patient completely for all activity.

When we recall what has been said in the previous chapters as to the extraordinary frequency of morbid states, brief and transient, enduring, or lifelong, we see that there

must result an enormous detraction from working capacity. Hardly any one can be found in whom a short, long, or permanent illness has not led to the loss of what he might have done had he remained healthy. Innumerable is the number of those who have had existence rendered difficult, and not small the number of those who have thereby been reduced to dire need. Moreover, apart from the direct consequences of illness, the joy of life is thereby greatly diminished or even annulled.

Functional capacity is impaired, not merely by diseases in the narrower sense, but in addition by all the abnormal states considered in the previous chapter. By this we do not mean that work done in the line of some one-sided development of faculty is worse done, for in this direction it is obvious that the abilities are usually well developed. But the person who suffers from an excessively one-sided development is lacking in all or in many other respects, and the values of his existence are thereby injuriously affected.

Man's functional activities depend not merely upon his capacities, but also upon the energy of his will, and this matter therefore requires particular attention.

We all know from personal experience the unfavourable influence exercised upon the will by morbid conditions of all kinds. Our energy is in abeyance, or sinks to a minimum. It is not merely that we cannot be active, but very often that we do not desire to be so. We lose interest in our ordinary occupations, they become indifferent to us, we cannot be bothered with our profession, our business, our scientific studies, although by a serious effort we should often be enabled to attend to our affairs. The will is paralysed. The impulse that formerly kept us at work is no longer operative.

Not only may the will be weakened by illness, it may also in this way have its direction diverted. This happens especially in the case of mental illnesses, but also in certain bodily illnesses when these react especially on the mind.

The man who has become mentally abnormal feels impelled to abnormal activities, to commit a crime, to injure or affront another man, to undertake some occupation he knows nothing about, to play the spendthrift, to push himself to the front on all occasions, etc. He is unable to resist these imperious impulses, unless indeed his judgment remains sufficiently sound to enable him to retain a sufficient degree of opposition to the insurgent desires.

We are accustomed to say of those who are dominated by such abnormal impulses, that the will is no longer free. This introduces a conception which requires careful consideration. It is commonly held to be a great good to have a free will. One who can follow his own will finds satisfaction, whereas to be hindered in the operation of the will is disagreeable and painful. Now when we observe that a morbid condition may not merely impair our will, diminish its strength, but may also induce new motives coercing our will to exercise itself in undesired directions; when we see, further, that all this happens to our fellow men, and that when they fall ill their free voluntary determination is often lost, that therewith may disappear also the consciousness of its loss, so that they lead no more than a blind impulsive life—then we come to recognise one of the most serious injuries inflicted upon us by illness.

We see, then, that the notion of the freedom of the will is of the greatest importance in our exposition. The capacity of mankind for evolution depends to a large extent upon whether we really possess the power to undertake the tasks that lie before us, or whether our will to undertake these be impaired by illness.

Does freedom of the will really exist? We know that this question has been fiercely debated from the earliest times, but the controversy is one upon which we cannot enter here. And yet it is impossible for us to leave the matter altogether unconsidered. It is necessary to explain briefly what we are to understand when we speak of

the freedom of the will. Then only shall we obtain a clear view of the manner in which illnesses affect the will, and of how, in this respect, they concern the subject we are considering.

When a man wills, his will is always and in all circumstances conditioned by something which has happened in the past, by something which is happening simultaneously, or by something which is conceived as going to happen in the future. An act of will never arises out of nothing, as something altogether new. It is invariably a product of certain conditions, one link in a chain of successive mental processes. The will does not exist as a phenomenon appearing suddenly, and in isolation from the rest of the mind. In the mental domain, just as in the physical, there is perfect continuity, or in other words causality; there is no interruption, no hiatus. The fact is obvious, and yet it is not universally believed even to-day.

In the individual, the will is determined by influences from without. Some external impulse induces a reaction. In so far as these reactions are purely reflex, we are not concerned with them here, but in so far as they are something more, they are acts of will. The act of will may be very closely dependent upon the external influence, so that the man, apart from the fact that the action proceeds from himself and is an outcome of his own personality, hardly seems to add anything new. We see this, for example, when to an attack he instantly responds with a blow. The difference here between the act of will and a reflex action is inconsiderable. In most cases, however, the external influence is not transformed so shortly and simply into an act of will. Most commonly the man contributes more or less on his own part. His individuality determines what form the reaction shall take. When the sun begins to shine the will is often immediately directed towards a country walk; but frequently other motives come into operation which conflict with the primary desire, ultimately inducing us to stay at home and to engage

in some more necessary occupation. Thus the constitution of our own ego decides against the external influences.

In other cases the individuality decides in the absence of any external impulse. The will is formed out of that which lives and works within us. Scientific experiments, for example, which we turn over in our mind lead us to conclusions which serve as the stimuli to further investigations. The will then comes into operation to direct us towards the new goal. Again, our thought-associations lead us to remember that it is a long time since we have seen a certain friend, and thereupon our will determines us to pay him a visit.

An act of will never appears in absolute independence; it is always conditioned. To this extent, therefore, there is no such thing as freedom of the will. No act of will can occur except as a part of some continuity. Do we experience this as a limitation? By no means. And wherefore not? Because all the conditions of the will that arise within ourselves are expressions of our own individuality, and are therefore felt by us to be welcome. In normal circumstances our will is always in harmony with our self; we cannot will in any other way but as the expression of that self. For this reason, the fact that the will is enchained in the continuity of the conditions that are operative within us is never experienced as a sense of lack of freedom. We feel ourselves free when we can follow our own impulses. The will is free because it is the outcome of our own individuality, in opposition to which we are unable to will at all. Free will is the capacity of the individual to act in accordance with his own individuality. This individuality is always and in all circumstances dominant, our will is dependent upon it, and to that extent is not free. It is true that there not infrequently occurs within us a struggle between motives, which may depend upon conflicting peculiarities of our own ego, or may be the outcome of external influences. In such cases, however, the more powerful motive is ultimately

decisive, and this is equivalent to the subordination of the weaker portion of our own individuality. Upon this, in these cases, the will is therefore also dependent.

What has been said is applicable mainly to healthy persons. In the diseased, the conditions are somewhat more complex. Here all kinds of pathological motives are in operation by which the will is determined. If, indeed, we regard these pathological motives as constituents of the sick man's individuality, if we affirm that the abnormal impulses, perversities, etc., are expressions of his own nature, then the conditions are identical with those which prevail in the healthy person. Sick man and healthy alike act in accordance with their own individualities. No practical objection can be made to this point of view. The significance of diseases is then manifest; they determine the thoughts and actions of human beings.

Yet we cannot rest perfectly content with this point of view, if only for the reason that we should then have to regard diseases as essential human qualities, attaching to humanity for all time. We must therefore look for a more satisfactory conception, and we shall find it in certain theoretical considerations which, indeed, cannot always be easily translated into practice.

Let us start with the healthy, normal human being. In such a one all desires, impulses, voluntary activities, are in mutual harmony and in harmony with those of his healthy fellow beings. Being parts of a great healthy whole, no contradiction can arise among them. In such persons, the individuality can manifest itself altogether without hindrance; in our sense of the term, the will is free. All that exists in them belongs to them; we cannot conceive of anything being taken away without the man's losing something from his personality. It is altogether different when diseased or abnormal motives come into play, or when one of the qualities becomes influenced by disease. Then we have the impression of some foreign element in action, which exercises a restrictive influence,

whereby the will of the healthy individual, or, to speak more strictly, of those portions of the individuality that remain healthy, is hindered in its operation.

We can conceive the abnormal characteristic removed, we can take it away in thought, without thereby inflicting any loss on the man. This is obvious, above all, in the case of physical illness, which always appears to us as something not properly belonging to the body, as something superadded, as foreign. Such, indeed, is its nature. The normal healthy human being is a type, and this type is deformed by the disease.

Nor are the conditions notably different where the mental individuality is concerned, although here the contrast between the healthy and the diseased is often made manifest with much greater difficulty, for the reason that the characteristics now run into one another to a far greater extent, and because at least the slighter divergences from completely normal behaviour masquerade as sterling peculiarities of the individuality. If, however, we sift the matter to the bottom, and if we take into account, above all, obviously abnormal motives, we perceive in this case also the contrast between the healthy and the diseased. The man himself, in so far as he still retains powers of self-observation, feels the pathological motives as something of a disturbing character, something hostile to himself; he cannot escape them; only with difficulty, if at all, only with internal struggle, can he follow the determinations of his own individuality in so far as this still remains normal. Thus the normal will is hindered in its operation, and in advanced stages of the illness is altogether suppressed. Pathological motives, such as those of the criminal, are then solely dominant, and the freedom of the will is in complete abeyance. This is the case because there no longer exists a normal individuality, of which alone free will is the outcome.

This is especially plain in the case of coercive ideas, or obsessions. These control the voluntary life either per-

manently or periodically. In many cases, the patient knows himself to be no longer free, and this often makes him unhappy. Similar considerations apply also to other marked mental disorders. They limit the individuality, and shackle the will in some particular direction. Especially is this true of cases of intermediate degrees of severity, for in the most serious types of mental disorder will can no longer be said to exist, while in the slighter manifestations of disease the abnormal motives may be compensated or altogether overcome by healthy ones. Impulses to crime may fail to come into operation because they are conquered by simultaneously recognised ethical motives, or owing to the recognition that punishment will follow, or as a result of the impressions left by education. In such cases, when a man overcomes his bad impulses he feels himself to be free because he helps the normal side of his nature to conquer, because he either follows his own inborn better impulses or those which education and instruction have made a part of his normal self. He does not feel the influence of these factors as coercion, but as something corresponding to his own inner nature. Yet he is just as dependent upon these normal motives, as he is dependent in other instances in which the morbid impulses gain control.

When, finally, we turn to consider the most trifling deviations from the normal, little peculiarities and oddities, it is not difficult to see that in these cases also there is something foreign in operation, that it is as foreign elements that they press to the front and enter more or less into control of the voluntary life.

We see, then, that all mental disturbances, slight or severe, lead to the suppression or limitation of what we have termed the freedom of the will, that is to say, of the capacity of the individual to act in accordance with his own individuality, or, as we may express it in virtue of the previous considerations, of the necessity (not felt as coercion) to follow the dictates of the individuality. Hence

the diseased and abnormal human being lacks freedom of the will. He is dominated by the necessity to yield to the morbid motives, while his obedience to healthy motives is impaired.

It is now necessary to observe that anomalies of the mental life are so extraordinarily common that hardly any one exists who displays not the slightest deviation from the normal. Hence there exists an enormous total of unfreedom of the will.

This total becomes even greater if we no longer confine our examination to the mental life, for all bodily disorders have a more or less restrictive influence in respect of free will. We referred above to the everyday experience that headache, toothache, and other trifling affections, are felt to paralyse our energies. How much more powerfully operative in this direction are those serious illnesses that turn the thoughts unceasingly in particular directions, often causing the sufferer to think of nothing but his own ego, making him weary of life, and depressing his will power. It is not necessary to discuss the matter in detail. To every one who has watched invalids or has himself been ill, it is a familiar experience.

We learn, then, that the influence of diseases upon the individual sufferers is enormous, so great that the gravity of their consequences cannot be overestimated. The vast majority of human beings experience therefrom a loss of functional capacity of shorter or longer duration, and sometimes lasting through the whole of life. No less extensive than this direct loss is the indirect loss which results from the diminution of energy, from the limitation of will; for will is an outflow from the healthy portion of personality, and when will is in abeyance even those who are best endowed by nature are unable to devote themselves to active work on behalf of the progress of the human race. To these must be added an even more serious trouble, the appearance of morbid, abnormal, unethical motives, which,

again, on the one hand restrict the operation of the normal will, and on the other bring the individual into manifold conflict with himself and his environment, and thus inflict upon him more or less serious injury.

CHAPTER V

THE SIGNIFICANCE OF DISEASES TO SOCIETY

THE primary influence of every disease is exerted on the individual patient, causing sometimes trifling and sometimes serious injury, and sometimes terminating his existence altogether. But the influence of disease extends far beyond the individual, not infrequently to regions altogether outside our ken; it may affect the sufferer's dependents, it may affect numerous other persons, it may affect posterity for untold generations. This extended influence is exerted in a twofold manner. In the first place, the sick man is no longer functionally capable of fulfilling the expectations of his social environment; and, in the second place, the disease itself may be transmitted to other individuals. Both of these matters need detailed consideration, and the present chapter will be devoted to an examination of the significance of diseases for the sufferer's healthy fellow-men, of the injuries inflicted by the diseased individuals upon their immediate associates and upon others, and of the injuries that arise from the actual transmission of disease from the sick to the healthy.

The patient's immediate associates suffer first of all from sympathy with his sufferings and from the need to care for his life. Every one who has known what it is to have a near relative seriously ill is well aware how the family and a wider circle of human beings (varying in extent with the sufferer's position) is sympathetically affected. Every one has seen how the pleasures of life and work are diminished for the invalid's associates, and how greatly their activities are impaired in consequence of the attentions

they have to pay to him. Should the illness result in death, the effect on the associates is yet more lasting, and may sometimes endure for years.

Moreover, in numerous instances, the means of subsistence of the sick man's associates are lessened or even altogether withdrawn, in consequence of the expenses attendant on the illness and owing to the loss of earning capacity.

The disadvantages extend far beyond the family. The sick man is unable to perform those services to his fellowmen which he would have performed had his health remained good. The loss in this regard is more important in proportion as the person affected with illness was more highly developed, and in proportion therefore as he was able to do more for the community at large.

In addition, numerous other disadvantageous results have to be considered.

In very many cases, the activities that are the outcome of the morbid state are directly injurious in manifold ways to those in the sufferer's environment. Persons affected with mental disorder, so long as the nature of their illness is not recognised and they are allowed to remain at large, are a continual trouble to their families, which are often brought to ruin; they commit offences against morality, becoming homosexual, for instance, and the prey of blackmailers; commit misdeeds of all kinds, theft, arson, etc.; make unceasing complaints, becoming troublesome and dangerous from delusions of persecution. Consider also the so-called "born criminals," who continually relapse into crime, and the alcoholics, who in a state of intoxication frequently commit serious punishable offences. Since the importance of alcoholism is especially great, this matter deserves fuller consideration. The objection might be made that alcoholic intoxication, being the expression of a mere transient poisoning, is not comparable to mental disorders, and that it must be placed in a different category. But in drunkenness there always exists a mental disorder,

even though this is of but transient duration. In consequence of this disorder, the man's value is temporarily diminished, and the inhibitions are suppressed that under normal conditions prevent the manifestation of morbid mental peculiarities. In a state of alcoholic intoxication the worse sides of the individuals come to light, and to this extent the proverb *in vino veritas* has its justification. Drunkenness shows us human beings with the wrappings off, and in contemplating its manifestations we often feel that these are not evoked solely by the alcohol. The effect of the drug is merely to lead to the display of all those characteristics which remained hidden when the drunkard was sober. This is proved by the fact that the effects of intoxication vary greatly in different individuals. The normal human being, or at any rate one free from morbid predispositions, is not led by alcohol to the commission of crime; but it is otherwise in the case of those whose psychical life was previously disordered, and whose morbid predispositions are now given free rein. The fact is not contested that in consequence of the long continued and excessive use of alcohol even a healthy individual may gradually become of inferior value and may develop morbid tendencies. On the other hand, it must not be forgotten that a truly normal human being would hardly become addicted to the immoderate use of alcohol.

The enormous significance of alcoholism in relation to the commission of major and minor offences has of late years been proved by temperance reformers and by the inquiries they have initiated. In an essay by Popert it is stated that according to investigations made by Baer, in the year 1876, of 32,837 prisoners confined in 120 German prisons, 13,706 had committed the punishable offence while under the influence of alcohol, and that every year in Germany no less than 180,000 persons are charged with offences committed while under the influence of alcohol.

It is only in a certain proportion of those suffering from mental disorder that the serious consequences to which

allusion has here been made are entailed upon the sufferer's fellows. In the others, and in cases of physical illness, no such consequences ensue. But in those thus excepted, as well as in many in the first category, other serious disadvantages arise. All invalids are partly or altogether unable to care for their own existence, or to take the necessary steps for the proper management of their illness and for the attainment of a cure. They require to be cared for, often for a long time and very thoroughly, whereby claims are made upon the energies of the patient's associates or upon those of specially engaged nurses who, if illness did not exist, could employ their faculties more usefully in other spheres. In a great many cases such care has to be given for the whole of life, which may be long. Let us endeavour to understand clearly what this signifies. The care for individuals who from birth onwards are useless alike mentally and physically, who for themselves and for their fellow-creatures are a burden merely, persons of negative value, is a function altogether useless to humanity, and indeed positively injurious. In these cases, the attendants lack even the personal satisfaction felt by those who are caring for the sufferers from transient illness, that they are helping to keep alive individuals of a more or less definite value. In the instances now under consideration the care seems purposeless. I do not, of course, mean to imply that these invalids should be left uncared for. I am merely contemplating the possibility that illnesses of this character might after all not exist, and that with their suppression the attendants would become superfluous. Those who are now ill could then themselves take part in the work of the community, and their attendants could be no less usefully employed, whereas at present, from the general outlook of humanity, the energies of these latter are simply wasted.

Our enumeration of the disadvantages and injuries entailed by illness upon society is still far from complete. In the majority of instances the deficient physical or men-

tal functional capacity of the invalid entails pecuniary losses upon his immediate associates. Often these losses are extensive and even irreparable, and death may rob the family of the bread-winner. In part, indeed, though by no means completely, this disadvantage is compensated by insurance. Even to-day, in cases of long-lasting illness, and where death ensues, the family is often reduced to dire poverty. This arises not simply from loss of earnings, but on account of the extraordinary expenses requisite to provide medical attendance, nursing, and medicaments. Certainly these evil consequences for the family are now far less serious than in former times. A system of national insurance provides for the expenses of illness, and hospitals see to the nursing. But the money must come from somewhere, being furnished in part by the insured, in part by the employer, in part by the municipality or the state, and in part by charity. Even if the immediate associates of the invalid are less affected by this burden than was formerly the case, the community still suffers. We now take this as a matter of course, and we seldom endeavour to represent clearly to ourselves what enormous sums are thus expended which, if all human beings were healthy, might be devoted to the general interest. A few examples may be given. An investigation made by Irving Fisher in New York shows that in the United States of America 138,000 persons die every year of consumption. The loss in earning-power, and the additional expenses which this involves, are estimated by Fisher at £200,000,000. Two hundred million sterling! What services to human development might be provided by all this money if we were freed from the burden of consumption. Consider, too, that, proportionally to population, what has been said of the United States is applicable to all the countries of the world. For consumption occurs everywhere in about the same proportions. In Germany, the yearly deaths from consumption number about 120,000. Moreover, the disease is exceptionally prevalent during the

most vigorous years of life. Of the deaths that occur during these years, about one fourth are due to consumption.

Estimates also exist as to the incidence of typhoid, a disease far less disastrous to humanity than tuberculosis, both in respect of its comparative infrequency and of its much briefer duration. Kirchner estimates that the 46,170 typhoid patients of the year 1900 (in Germany) cost, in nursing and in the burial of the dead, about £500,000. He further estimates the annual cost of venereal diseases at about £4,500,000.

Lomer has made an estimate for mental disorders. He shows that in public institutions in Prussia during the year 1900 nearly 60,000 lunatics were cared for, and that this involved a cost of £1,500,000. If we add to this the expenditure of the other states of the German confederation, we obtain a total for Germany of £2,500,000. Lomer further estimates the cost of lunatics cared for in private institutions at another £2,500,000, so that the total annual cost of mental disorders in Germany amounts to £5,000,000. The costs of administration for the provision of doctors, officials, nurses, and attendants are not included in this calculation. "This is a colossal total, and we have to remember that all this expenditure is of use only in a negative sense, effecting merely the segregation of these invalids from the social organism. No results of positive value are derived from the enormous drain upon the public purse."

Pelman gives a characteristic example from the life history of a single family. Dugdale, an American investigator, came across six members of this family in prison. He traced back the family records to 1740, and was able to ascertain the fate of 709 of its members. As a whole they had spent 116 years in prison, and had been supported by the public during 734 years. In the 75 years to which the investigation extended they had cost the State £250,000.

These examples will suffice. They make alarmingly plain the incredible magnitude of the expense entailed by

illness upon the family and upon the community at large. If we take further into consideration that invalids are often a hindrance to their families in various other ways, that owing to their illness their fellow-men are deprived of valuable services, that they inflict upon their fellows countless injuries of other kinds, that they have to be cared for by innumerable persons whose energies might be better employed, the total of the disadvantages entailed by illness upon society becomes immeasurably great.

In a very large number of instances, in the case of the infectious diseases, the incidence of the illness is not confined to the person first affected, for the disease itself is transmitted to the sufferer's fellows, owing to the fact that the exciting causes, micro-organisms for the most part, but sometimes other living creatures, are actually communicated from person to person. The methods of transmission are extraordinarily diverse. The exciting causes of disease may be transmitted by direct contact from the sick body to the healthy one. In the case of the diseases dependent upon wound-infection it often happens that a healthy individual sustains some slight injury while performing an operation, a surgical dressing, or a post-mortem examination, thus introducing the micro-organisms into his own body. A medical man, again, who has some infective process going on in one of his fingers may infect another person in the course of an examination, while attending a woman in child-birth, for instance. Anthrax is mainly acquired through wounds received while handling the carcasses and hides of animals which have been affected with this disease. In the case of many of the infectious diseases, such as measles, scarlatina, and smallpox, we are still ignorant of the precise means by which the infection is transmitted. It may take place directly from person to person, but it may also be effected by the intermediation of other individuals, and by that of inanimate objects (articles of clothing, toys, etc.) which have been in contact with the patients. In the case of diphtheria and of

whooping-cough the same methods of infection also prevail, but in the transmission of these diseases direct infection as a result of coughing, by which mucus, etc., containing the infective organisms is expelled by the patient and then in one way or another transferred to the healthy, plays a far more important part. Similarly in the case of tuberculosis, the danger is ever present of the transmission of the disease through expectoration and coughing, whereby materials containing tubercle bacilli are disseminated in the air and may be inhaled by healthy individuals. There is also a danger that in ordinary conversation minute drops of fluid may be expelled from the mouth; in the tuberculous these often contain bacilli which may then be inhaled by healthy persons. Diphtheria and whooping-cough may likewise be transmitted in this fashion. Tuberculosis is disseminated in yet other ways. The bacilli expelled by the patient are deposited upon furniture, articles of clothing, the floor, etc., and as soon as the expectorated material has become dry and is disseminated in the form of dust it may be inhaled by any number of people. A child, again, may introduce a finger contaminated with such material into its mouth or nose. It is also possible that through uncleanliness bacilli may find their way into food; for example, a child's milk may become contaminated in course of preparation by a mother suffering from tuberculosis. The bacilli then enter the intestine with the milk and thence find their way to other organs. The inhalation of dried and pulverised sputum may lead to infection by the same channel, for a portion of the inhaled dust lodges in the mouth or pharynx, is subsequently swallowed, and thus finds its way into the intestinal canal. The bacilli may also enter the body directly from the pharynx, especially through the tonsils. Tuberculosis is rarely transmitted by wounds. The transmission of acute pneumonia by direct infection from person to person is hardly known to occur, but when the micrococci which cause this disease obtain lodgment on

the walls or in the flooring of the patient's room they may retain their vitality for a considerable period and may ultimately find their way into the body of another individual. Such prolonged intervals in the transmission of infection are possible also in the case of the tubercle and the diphtheria bacillus. Direct infection is observed in cholera and typhoid when healthy persons handle the patient's evacuations in a careless or uncleanly manner, and infect themselves directly or through the instrumentality of food or drink. Washerwomen, also, may be infected with these diseases, when handling soiled linen. In most cases, however, typhoid and cholera are transmitted through the instrumentality of water into which the exciting causes of the disease have found their way, and which is subsequently drunk by healthy individuals. It often happens that the contaminated water is employed to wash milk cans or other utensils in which milk is stored, or is used to dilute milk, which is thus rendered infective. Danger of infection also arises from the washing of vegetables, and especially of salad, in germ-contaminated water. There are other infectious diseases in which the method of transmission is even more complicated. The intermediary may be another animal, in which the infective micro-organism is also able to live. In the diffusion of bubonic plague, for example, it is now well known that the rat plays an important part. Malarial fever and sleeping sickness are diffused by the intermediation of certain biting insects. These suck up the blood of individuals suffering from the diseases in question, in whom the blood itself contains the living organisms that cause the disease; and after the organisms have undergone certain changes in the body of the insect-host, this last by its bite inoculates a healthy individual with the disease. Animal parasites of a higher order, such as the filaria met with in the tropics, may be transmitted in a similar way. Every one knows that tapeworms and trichinae have as intermediate hosts certain animals used by us for food (cattle and swine), and that

the parasite is transmitted to healthy individuals through the ingestion of meat containing the parasitic worm.

These examples may suffice. For the purposes of the present book it is unnecessary to give a more detailed account of the methods of transmission. All that we are here concerned with is to recall to the reader's memory how extensive and manifold are the possibilities of dissemination of such diseases, and how dangerous in consequence are the sick to their healthy associates. It is hardly necessary to insist upon the colossal extension which may be attained by such diseases, especially tuberculosis, diphtheria, measles, scarlatina, cholera, typhoid, bubonic plague, smallpox, etc., in consequence of repeated transmission from person to person. The fact is always before our eyes in recurrent epidemics of such diseases.

CHAPTER VI

THE SIGNIFICANCE OF DISEASES TO THE OFFSPRING

THE offspring have to suffer in manifold ways from the effects of the diseases of the parents, and in part also from the effects of those of earlier direct ancestors. This matter is one of very great importance, for the evolution, the future, of the human race depends upon its offspring. If these are always being injured, and if this process continues for all time, there is little hope of any improvement upon present conditions, little prospect that the human race will ever be able to attain to a higher level of average well-being and happiness. The question is therefore one of lively interest whether the infliction of injury on the offspring by the diseases of their progenitors will necessarily continue through all future ages, or whether it will be possible to diminish or even to abolish these injurious consequences. To enable us to answer this question we must first consider the various eventualities that may lead to injury to children and children's children.

A. INJURIES INFLICTED UPON CHILDREN BY BAD UPBRINGING AND EDUCATION

Whilst brief and transient illnesses affecting the parents cannot react unfavourably to a notable extent upon the upbringing of their children, illnesses of long duration necessarily prove injurious in many ways. Sick parents cannot take proper care of their children, and may be forced to neglect them altogether; the children are then

deprived of parental influence and instruction, and in most cases no substitute is provided to compensate for this loss. Undoubtedly, not all children will be seriously injured thereby. Upon those whose inherited tendencies are good, the illness of the parents may occasionally exercise a good educative influence. There can be no doubt, however, that as a rule the lack of parental instruction has injurious results. School cannot provide a substitute for parental care, especially in view of the fact that schooling does not usually begin before the sixth year of life.

In such cases the defective upbringing takes the form, first of all, of an inadequacy of mental and especially of ethical training. Sick parents, and above all parents whose own moral level is a low one, are incompetent to care for the moral development of their children, and may even favour the moral degeneration of these by bad teaching and example. It must not be forgotten, moreover, that the children of such sick parents are apt, by inheritance, to start in life with a defective equipment, a question soon to be considered; but it is obvious that there will be a much stronger tendency for the children to develop along wrong lines when the parents set them a bad example. In families addicted to crime the children are often directly taught theft, lying, etc. It is well known, also, that such parents often deliberately neglect their children, and even mutilate them in various ways, in order to arouse pity, and thus extort money from the charitably disposed.

Of no less importance is the inadequacy of the bodily care provided for the children of abnormal parents. When the mother is ill the child is often badly nourished from very early days, and even from birth. The mother's milk, the child's natural food, is not forthcoming, and the child is brought up on cow's milk or even on milk-substitutes. Failure of the mother's milk occurs in many serious illnesses, such as severe tuberculosis; but incapacity for suckling may also depend upon a defective development of the mammary glands, which may be inherited, and which

by some is believed to be a consequence of the excessive use of alcohol on the part of the parents or even the grandparents of the woman who is incompetent for lactation. This question will be considered later.

In many cases, however, the failure to suckle the infant is not due to the mother's defective physical development, but to the fact that her mental disposition is a bad one. Often a woman does not wish to suckle her child, because of the inconveniences entailed. Here we have to do with individuals of inferior value who prefer their own comfort to the well-being of their children. The disastrous results of the artificial feeding of children are continually being emphasised by medical science and confirmed by medical experience. Artificial feeding is chiefly to blame for the tragic extent of infantile mortality, for the fact that from 20 to 30 per cent. of all children born succumb during the first year of life. Let me repeat, that of 100 children born, as many as 30, and here and there an even larger number, die in earliest infancy. How much distress and misery, how much heedlessness and frivolity, underlie these figures! How great, too, is the loss of capital. It has been calculated that for every one of these children there has been expended 250 dollars of national property. The total waste involved will become evident when we remember that year after year in the German Empire alone 250,000 children die during the first year of life.

This enormous infantile mortality, which is such a scandal to our civilisation, is mainly dependent upon defective or erroneous nutrition, and this in turn comes chiefly when the mother cannot or will not suckle her child. Mother's milk is the most natural food for the infant. Cow's milk, however carefully prepared, can never be a perfect substitute, though it is the best available. And in this domain of infant feeding what sins are committed in the giving of improperly prepared cow's milk, or in feeding infants from foods from which milk is absent. No doubt this often arises from poverty, where the means do not per-

mit of the purchase of enough milk for the child; but this poverty, in turn, is frequently the outcome of illness in the parents whereby their earning capacity is impaired. Nor is poverty the only cause. Ignorance, erroneous teaching, an obstinate adhesion to tradition, and superstition, all play their part, and these are conditions dependent upon the fact that the mental constitution of the parents is below par value, and often definitely diseased.

It may be admitted that of late years there has been some improvement, that there has been a decline in infantile mortality. This improvement, however, does not depend so much upon the provision of better conditions by parents, as upon advance in medical skill; upon the municipalities, where these provide for the supply of sufficient quantities of properly prepared milk at the lowest possible price; and upon the state, in so far as this has taken steps to secure an improvement in sanitary conditions. The morbid dispositions of parents, the inferiority of their values, persist unchanged.

The injurious effects of illness are not confined to the first year of the child's life. Numerous children who survive the year of infancy subsequently succumb to the effects of bad nutrition, while others are thereby permanently weakened.

In certain districts, moreover, alcohol is given to children, chiefly in the form of beer. The parents, who are themselves addicted to the excessive use of beer, regard it as a suitable and strengthening article of diet for their children. We cannot go so far as to say that all the parents who give their children alcohol are themselves diseased in the strict sense of the term. To a large extent, certainly, we are here concerned merely with the thoughtless adhesion to a traditional local practice. Yet it must be admitted that such parents are necessarily below par value in the matter of intelligence, for otherwise they could not fail to recognise that a beverage capable of producing intoxication in the adult must be unsuitable for the

immature organism. Hence in this case also the injury to the children is dependent upon the morbid constitution of the parents. [Fortunately Anglo-Saxon children are not poisoned by beer; but how often do we habituate them to the use of tea and coffee!—W. J. R.]

Disadvantageous in manifold ways as is the illness of the parents to the upbringing of the children, the death of father, or mother, or both, is apt to prove even more disastrous. The father's death removes the breadwinner, and the poverty of the family then often becomes extreme. By the death of the mother, the developmental chances of little children are especially impaired. It is quite true that the death of parents who are mentally disordered may be advantageous for the ethical upbringing of their offspring, if the result is that the children are now brought up in other families or in suitable orphanages. Apart from these exceptional cases, we cannot fail to recognise that the lack of parental training is always disadvantageous to children.

B. Appearance of Diseases in the Offspring. Heredity

In the previous section we gave an exposition of the disadvantages from which children suffer when the parents are incapacitated, owing to illness, from giving proper attention to the bodily and mental upbringing of their offspring. In such cases there often results a serious impairment of the proper course of development, the children not infrequently becoming ill both mentally and physically. A no less serious danger arises because the illnesses of the parents may affect the offspring, not only or not mainly through defective upbringing, but by the direct transmission of disease.

Such transmission is facilitated, in the case of diseases caused by micro-organisms, by the close relationships between parent and child, in consequence of which infection very readily results. This is seen, for example, in the case

of tuberculosis. Reference has previously been made to the fact that one of the greatest dangers in this connexion is that the mother may infect the child directly through the expectoration of tubercle bacilli, or indirectly through contaminating the child's milk or other food, and also that the children may infect themselves through the handling of dirty objects, contaminated by expectorated bacilli.

The transmission of infectious disease from parent to offspring may, however, also be effected before birth. In this connexion there are two possibilities. First of all, the disease-producing influence may affect the developing child within the mother's womb, and, in the second place, it may operate upon the so-called germinal cells, that is to say upon ovum or spermatazoön before the occurrence of that union between these cells which is known as fertilisation. This latter possibility is of especial interest and importance because we are here concerned with an injury, not merely to the particular individual produced by the union of the germinal cells thus affected, but also with one of the remoter offspring, perhaps for many generations. For a disease of the germinal cells is transmitted to the germinal cells of the developing child, and therewith to the individuals that will be produced out of these germinal cells in a subsequent generation. This is what we mean by inheritance.

Owing to the enormous importance of this matter to human evolution, its detailed consideration is essential. First of all we shall give a general description of the manner in which diseases of the parents may influence the germinal cells and the individuals produced out of these.

Let us begin with the germinal cells. In the diseased body, these may be affected by many injurious influences. When any poison invades the parental organism and makes this ill, the poison may have an effect on the germinal cells just as upon any other cells, and may induce changes in these. If a germinal cell thus rendered abnormal now unites in the process of fertilisation with a germinal cell

of the opposite sex, the alterations that have been induced may take effect within the developing ovum, giving rise to changes varying according to the nature of the poison and to the specific effect it has exercised upon the germinal cell, but which may take the form of deviations from the normal structure now in one organ and now in another, inducing disease, perhaps in childhood, perhaps later in life. Inasmuch as we are forced to conceive that in some way or other the germinal cells already contain the rudiments of the various bodily organs, these latter may be individually injured. For example, if the rudiment of the brain suffers, mental disorder will subsequently result.

But poisons introduced from without are not the only ones that may affect the germinal cells. The poisons that act in this way may also originate within the body, and here we think especially of the working of the micro-organisms which produce the infectious diseases. For the disease-producing activities of these organisms depend mainly upon the toxins that they manufacture; mingling with the blood these toxins find their way to the reproductive glands. In the second place, however, there are poisons that arise spontaneously in the diseased body, as when altered organs, such as the kidney, fail to eliminate substances which are normally eliminated in the urine. Being retained in the body, these substances act as poisons. It may also happen that the affected organs, whose normal task it is to render certain products of tissue-change harmless, are no longer able to do their duty in this respect. Finally it may happen that the altered organs, whose proper function it is to provide certain substances essential to the normal body, produce substances of altered composition which exercise an injurious influence.

A great deal more will have to be said in this book of these various possibilities of germinal intoxication in our discussion of the problems of the inheritance of disease.

It is also necessary to point out that when the parental organism is greatly weakened by disease, the germinal

cells may suffer from an insufficient supply of nutriment.

In addition to diseases in the narrower sense of the term, there may arise in the offspring various conditions which, though they cannot themselves be regarded as necessarily morbid states, yet render the organism unduly liable to the onset of disease.

Certain infectious diseases affect the germinal cells in a special way, inasmuch as the micro-organisms which are the exciting causes of the diseases in question invade the germinal cells without depriving them of their fertilising power and without interfering with the earliest stages of subsequent development. When, at a later stage, the organisms undergo multiplication in the growing individuals they may then give rise to the changes characteristic of their action. In the disease of silk-worms known as pebrine, for example, we are able to observe under the microscope that the exciting cause is present in the eggs of the insect, being thus transmitted to the new generation of silk-worms and in them reproducing the disease.

As far as human beings are concerned, this mode of germinal infection has to be considered, above all, in the case of tuberculosis. The matter has been greatly discussed whether tubercle bacilli invade the germinal cells, but investigators are now generally agreed that if this ever does occur in man it is extremely rare. No one has yet succeeded in demonstrating under the microscope the presence of tubercle bacilli in human ova or spermatozoa. We learn, however, from experiments on animals that the invasion of the germinal cells by these organisms is possible. In birds, tubercle bacilli have been introduced into the peritoneal cavity, where they come into contact with the ova. It has been shown in these cases that the ova can be fertilised and that the eggs will develop, but that the chickens are tuberculous when hatched. A similar process is conceivable in human beings, for in cases of peritoneal tuberculosis in women the bacilli might invade the ovum. As a rule, however, in this disease, the woman is so ill

that fertilisation does not occur. It follows that such infection of the ova must be extremely rare in human beings. In the semen of tuberculous men bacilli are so rarely found that the possibility that tubercle bacilli might enter the ovum in company with the spermatazoön in the process of fertilisation is extremely remote. If the male reproductive glands are actually affected with tuberculosis, so that they contain large quantities of bacilli, the danger of transmission to the offspring is inconsiderable, for the reason that the changes resulting from the disease commonly prevent the formation or at least the evacuation of the semen, and therewith render fertilisation impossible.

Less improbable than infection of the ovum by bacilli introduced with the semen is the occurrence of infection in this way, that the bacilli thus introduced into the uterus may sooner or later, but after fertilisation, infect the developing embryo. Certain experiments on animals indicate that this is possible, but the occurrence is altogether exceptional.

Syphilis is another disease in which the possibility of germinal infection has to be considered. In the case of this disease the general assumption used to be that the transmission of the exciting cause was frequently effected by means of the spermatozoa of syphilitic fathers. Of late years another view has gained ground, and it is now regarded as more probable that the man first infects the woman and that she subsequently infects the developing infant in the manner shortly to be described.

This is all we have to say concerning injurious influences exercised upon the germinal cells by illness in the parents. We must now turn to consider the injuries to which the child is exposed in the course of its development within the mother's body, in consequence of disease with which the mother is affected at the time. In this case, also, several possibilities have to be taken into account.

One source of injury may be found in the fact that the embryo is nourished by the mother through the inter-

mediation of the placenta. Substances in solution pass from the maternal blood into that of the child. If the mother's blood contains certain poisons, these may pass into the child's blood by way of the placenta, just like the normal nutritive materials, making the child ill or even leading to its death. Among such poisons, alcohol must be mentioned, although we know less about its influence upon the embryo than we do about its significance in relation to the germinal cells. The other poisons mentioned above may also prove injurious to the developing child.

There is also the possibility that when the mother is suffering from infectious disease the exciting causes of this disease may invade the embryo, and this chiefly by way of the placenta. This may happen in the case of tuberculosis, though perhaps this method of infection is not of frequent occurrence. We know, however, that the placenta is not rarely affected by tuberculous processes, and that bacilli are, of course, present in the lesions. It is possible that these bacilli may invade the embryo. The more serious the disease in the mother, the more numerous the bacilli in the placenta, the more readily will the child become infected. In those cases, for example, in which the mother dies at the end of pregnancy or during parturition from a rapid tuberculosis, we are often able to demonstrate the abundant presence of bacilli in the body of the infant. Where the mother's tuberculosis is less severe and the child is still-born or dies shortly after birth, we are sometimes able to demonstrate the presence of tuberculous foci. If in children dying a few weeks or months after birth we find extensive tuberculosis, we are justified in assuming that the disease already existed at the time of birth and arose in the manner above described. In general, instances of congenital tuberculosis constitute no more than a trifling percentage of all cases of this disease. It has, however, to be admitted that some authorities are of opinion that congenital tuberculosis is of comparatively frequent occurrence.

Apart from tuberculosis there are in practice not many diseases which have to be considered in connexion with the possibility of infection through the placenta. Such transmission has been observed in the case of anthrax, typhoid, small-pox, scarlatina, measles, acute pneumonia, wound-infections, erysipelas. The three diseases last mentioned are of especial interest because they are responsible for the occurrence in the embryo of inflammations of the valves of the heart. But these affections are rare.

Injuries to the child within the body of the mother may also arise in consequence of pathological conditions in the uterus. There may be insufficient space for the child; the uterus may be displaced; the umbilical cord may surround some part of the embryo, especially one of the extremities; the membranes may adhere to the surface of the child's body. In this way there arise various disturbances of development, more or less serious malformations.

This, however, is not the only way in which malformations arise. Many of these are dependent upon diseases of the germ, arising under conditions to which reference has already been made, transmitted, for instance, from previous generations. Many malformations are transmissible by inheritance; the changes in the germinal cells by which they are induced may have originated in the grandparents or great grandparents, or even in remoter ancestors. This question will be more closely considered when we come to deal with the inheritance of diseases. But first we have to occupy ourselves with the general principles of inheritance, for without a knowledge of these it is impossible to understand the process of the inheritance of disease.

For, notwithstanding numerous peculiarities by which the inheritance of morbid states is distinguished, this peculiar phenomenon is merely a part of the general phenomena of heredity, and the former cannot be fruitfully considered except in connexion with the latter. Consequently, before we discuss the hereditary transmission of diseases,

we must inform ourselves as to the general conditions of heredity, as to its anatomical basis, and as to other matters.

1. *General Phenomena of Heredity*

We know from ever-recurrent experience that no one living human being is perfectly similar in all details to another individual of the same species. Every plant, every animal, differs from its fellows, and these differences exist not only as regards the individual as a whole but also as regards all its parts. No leaf corresponds in every characteristic with any of the innumerable other leaves of plants of the same species. It is the same with human beings. Not one of us can be exchanged for any other, and even if in exceptional cases there exists an intimate resemblance between two individuals, a close examination soon shows that differences exist both in mind and body. We may go so far as to maintain that two absolutely similar men never have existed in the past and never will exist in the future. The number of individual human characteristics is so great as to render it impossible that two human beings should ever exhibit the same combination, the same number, and the same arrangement, for all the myriads of individual characteristics.

Thus every human being is a peculiar individual whose perfect counterpart can never be found. The explanation of this is not that all human beings start alike, and that they only become different subsequently because the vital conditions, the environmental influences that affect us, which are never exactly the same for any two living beings, have evoked the various individual peculiarities out of primarily homogeneous rudiments. For the most part nutritive, housing, and climatic conditions, and the other environmental conditions surrounding our youth, wherein all these differences become manifest, are similar to such a degree, that it would be impossible for the comparatively slight differences that do exist in these conditions to give

rise to the unending multiformity in the personal characteristics of mankind. There is no other possibility than that individual human beings are different from the start, that they differ as to their rudiments. No one really questions this. Yet the most markedly developed individuality is far from being rigid and unalterable. Just as the physical characteristics undergo gradual transformation in the course of life, so also there ensues a change in the mental peculiarities; and this does not occur only from within outwards, for reasons dependent simply upon the spontaneous development of the individual as age advances, but it also arises as an outcome of the influence of numerous external conditions. Not one of us doubts that if the circumstances of his life had been different, his development would have taken a different course, above all as far as mental characteristics are concerned. We can well conceive that one whose upbringing has led him to exercise his faculties in the domain of pure science might, under other conditions, if he had grown up in another family, have developed a remarkable aptitude for music. Such possibilities are innumerable. But would such changes in his activities seriously alter the individual? Would a different individual thus be created, in whom the other individuality could no longer be recognised? Obviously, nothing of the kind could take place. All that happens in such cases is merely that another side of the individuality becomes conspicuous than the one which, under other conditions, would have been specially developed.

Thus the only change that has been effected is one which concerns the mutual relationships between the individual characteristics. No new element has been introduced. All that has happened is that one or other side of the individual has been rendered more conspicuous than would have been the case under normal conditions.

To express the matter in other terms, we have in such cases adapted ourselves to the changed external influences;

we have brought our faculties into harmony with the demands made upon us.

But this capacity for adaptation to special vital conditions is just as much an inborn characteristic of living beings as are the innumerable individual differences of which we have been speaking, and upon whose modifiability within certain limits we have been enlarging.

All these peculiarities, including the power of adaptation, attach to the individual and endow him with his characteristic quality, make up his individuality. But they are not merely attached to him; they are altogether inseparable from him. We cannot conceive of any human being as really existing utterly devoid of individual characteristics, of one who would be simply "man," and not this, that, or the other particular man whose double is nowhere to be found. On the theoretical plane such ideal living creatures can be constructed, of which two specimens may be conceived to resemble one another in every possible detail, but in the concrete no such specimens exist. Ideal forms, like those created by Greek sculpture, have no actual existence.

We know already, and shall learn more precisely, that all living creatures are the offspring of pre-existent living creatures, originating from small portions of the parent organisms, and developing out of the growth of these portions, which pass by the name of ova. Upon this depends the fact that, as far as we are able to observe, animals and plants of any particular species are always the offspring of that species, that man is always born from man. In the ovum out of which the living creature develops there already exists the potentiality of the individual subsequently to be formed, although no structural evidence of this potentiality can be discerned by our senses. The ovum of any kind of animal always produces an animal of this kind, and however much we may alter the environmental conditions it never develops into a living creature with characteristics belonging to another species.

From the human ovum there invariably develops a human being, and this is not "man" in general, but a peculiar and individual human being differentiated from all others. It follows that there exist in the ovum the rudiments, not merely of the general peculiarities which distinguish men as men, or the animals of any other species as such, but also the rudiments of all the special bodily or mental characteristics by which the individual is distinguished from all others of his own kind. This conclusion is not imposed upon us solely by theoretical considerations, which show us that no other possibility is conceivable than that all these innumerable characteristics should be potentially represented in the ovum, but it is also a necessary deduction from certain observations subsequently to be described.

If this is so, if we proceed from parts of our parents, we may assume that the developmental possibilities whose existence in the germ has to be presupposed, and in consequence of which the individuals subsequently to be formed come into existence, will harmonise with the qualities of the parents. For the part will contain no other peculiarities than the whole, which is in this case the parental organism. It follows that the children will possess the same characteristics as the parents, that the former will resemble the latter. This is precisely what we understand by heredity. Heredity is, indeed, often conceived as a transmission of parental qualities to the offspring. A detailed examination will be necessary to enable us to determine whether this conception is really accurate. For the present we shall regard the term heredity as merely an expression of the fact that offspring resemble parents through the intermediation of the germinal cells. We are careful to use the term "resemble." Heredity never results in a complete reproduction of qualities. Parents and children are distinguished from one another in their characteristics just as are all other human beings, though there is more resemblance between parents and children than between individuals not thus related. How does this

come to pass? Under the conditions with which we are concerned there are three reasons.

First of all it must be pointed out that individual human beings may experience, through the influence of particular vital conditions, a development of their rudimentary tendencies different from that which has occurred in the parents. Attention has already been drawn to this possibility. Thereby certain divergences between offspring and parent may be induced. We must repeat, however, that in this way no essential difference can arise, that no new characteristics are thereby introduced into the child's body; all that can happen is that the pre-existent characteristics may experience a greater or a lesser development.

Secondly we have to consider that a child is never derived from a single parent, but always from two, and that it therefore represents an admixture of the peculiarities of the father and of the mother, individuals who differ each from the other. By this admixture, characteristics may be juxtaposed in the children which exist separately in the parents, and peculiarities common to the father and the mother may, owing to a summation of effects, attain an especially marked development in the child. Upon this, in part, depends the fact that in children certain characteristics may arise to all appearance spontaneously, when such characteristics were present in the parents only to a moderate extent. Other qualities may restrict one another's development, exercising a mutual inhibition so that they cease to be noticeable. Or, again, a mingling of characteristics may lead to the appearance of some quality which was non-existent as such in the progenitors. To give an example, by the union of tendencies to the production of black hair and of fair hair, an intermediate colouration might arise in the children. But we must not overlook that the cause of the production of this new tint is also to be found in the constitution of the parental parts. The hair of intermediate colouration has had its existence rendered possible because of the pre-existence in

the respective parents of tendencies to the production of black hair and of fair. In this sense, therefore, we may say that the dissimilarity of the child's hair is itself an inherited quality, but we are accustomed to speak of hereditary transmission there only where we have to do with resemblance between progenitors and offspring. To avoid confusion we shall therefore express ourselves in other terms, and emphasise the fact that both similarity and dissimilarity depend upon the constitution of the parental parts from which the offspring proceed. In saying this we are also asserting that, inasmuch as there is no way in which any new element can be introduced into the individual, all the rudiments we encounter in the child have pre-existed in one way or another in the parental parts.

While we are thus led to infer that the offspring may result from an admixture of parental tendencies, we must not fail to insist that such an admixture is far from being the rule. The separate inheritance of characteristics is much commoner, and is much more important in relation to the present discussion. Dark hair and fair hair, and all other individual characteristics, generally make their appearance distinctively in the offspring, and not as an admixture of parental characteristics. This matter will subsequently be considered in further detail.

There is a third and no less important explanation of the frequent differences between parents and children. We find in the children the characteristics, not only of parents, but also of grandparents and of remoter ancestors, although these characteristics have not been exhibited by the immediate progenitors. It is thus possible that qualities of the grandparents existed in certain parts of the parents, that is to say in the maternal ova and the paternal spermatozoa by whose union the children were formed, without the parents themselves having manifested the characteristics in question. To this matter we shall return. For the moment we shall merely indicate that the condition in which such grandparental qualities exist in the

parents is known as one of *latency*. This means that in the bodies of the parents the qualities in question are ineffective and concealed, so that we cannot perceive their existence. When a child resembles a grandparent or a yet remoter ancestor, we denote the phenomenon by the term *atavism*. It is necessary to lay much more stress upon such inheritance from grandparents and remoter ancestors than is commonly done—at any rate outside scientific circles. In daily life when people speak of heredity they generally take into account no more than inheritance from father and mother. Even if it be recognised that grandchildren may resemble their grandparents as well as their parents, the possibility of inheritance from great grandparents and from ancestors yet further back in the scale is commonly ignored. Yet it is essential to recognise the existence of this phenomenon, for then only does the extraordinary many-sidedness of the individual, then only do the multiple divergences between offspring and parents, become fully comprehensible. We have now ascertained the reasons for the existence of differences between parents and children. But such dissimilarity is not the most notable feature of this relationship, for the likeness between parents and offspring is far more obvious. It is of resemblances that we think when we speak of heredity. They are our leading interest, and it is with them that we must be chiefly concerned.

The most conspicuous manifestation of heredity, and the one therefore whose existence can most easily be established, is the inheritance of body peculiarities.

When we speak of a resemblance between parents and children we think especially of their bodily structure. The stature, the colour of the eyes and of the hair, the shape of the nose and of the ears, and many other physical characteristics, are often transmitted from parent to child through several or numerous generations. Every one will readily recall examples of this in his own family or in those of his acquaintances. Such inheritance often extends

itself to quite unimportant details. Thus there is a family in which a white lock of hair has been transmitted by inheritance for several generations. A widely celebrated instance of such inheritance is that of the strongly developed lower lip of the Hapsburg family, which has been transmitted during six centuries, persisting, that is to say, through about 18 generations. The inheritance of mental peculiarities is less easy to establish than that of physical. This is readily comprehensible, seeing that mental capacities are not transmitted in a fully developed state. It is only the rudiments of the mental functions that are inherited. The functions gradually develop at a later date upon the foundation of these rudiments, which are often quite unnoticeable in the child.

There can, however, be no doubt that such rudiments are really transmitted by inheritance, and that they do not originate *de novo* in the developing organism. To some degree the mental capacities belong to man as such. As members of the human species, individuals are distinguished by particular mental tendencies, which are continually retransmitted from parents to offspring. Man as man is just as definitely distinguished by mental as by bodily characteristics. But the development and the occurrence of such qualities vary greatly in different individuals, and consequently inheritance, outside the general lines of its action, manifests itself in this way, that parents and offspring resemble one another in respect of the strength and combination of the individual tendencies.

De Candolle made a remarkable investigation on this point. He took note of the distinctive characteristics exhibited by sixty men, and then examined their sons. He established that 90 per cent. of the qualities were common to fathers and sons, whilst as regards the remaining 10 per cent. of the qualities, these were either common to sons and grandparents, or were explicable on the ground of the above-described admixture of the parental qualities.

Heredity displays itself in a more characteristic way

when we have to do with very peculiar or striking mental qualities.

We all know, and especially every one of us has learned at school, that the inborn tendencies characteristic of human beings are extraordinarily diverse. We continually encounter children who appear to possess exceptional endowments in one direction or another, who exhibit a remarkable capacity for mathematics, for example, for music, painting, or poetry. Galton established this in the course of a statistical investigation made in an English school, having examined during two years the mathematical aptitudes of the pupils of the same class growing up under like conditions. He showed that the great majority possessed only a moderate mathematical faculty, that a smaller proportion were somewhat better equipped in this respect, that a few only exhibited a high development of the faculty, while one altogether outdistanced all the rest.

The most remarkable instances of exceptional development of inherited faculty are met with in the so-called infant prodigies. I need merely recall that Mozart's performances were astounding even in early youth. Indeed, it is especially in the case of music that such early development of faculty is a familiar experience; and we are continually meeting fresh examples of phenomenally musical children. A similar early development occurs in many mathematicians. Gauss says jestingly of himself that he could calculate before he could speak. I may also mention the physicist Thomson (Lord Kelvin), who began to attend the university at ten. It is not necessary to give any additional instances.

Such altogether exceptional development of faculty is characterised especially by this, that the faculty finds expression even when the external conditions are unfavourable, when all kinds of obstacles are imposed, when the individuals thus endowed have to contend with poverty, or when the parents endeavour by threats or otherwise to interfere with a special bent. We often hear how

great men have had to overcome such obstacles. It is reported, for instance, that one of the Bernoulli, a member of the celebrated family of mathematicians, was continually being blamed by his parents for his devotion to his chosen science, while another member of the family had to work in secret. The father of Pascal, the celebrated mathematician, threw many obstacles in the way of his son's studies, regarding them as injurious to the lad's health.

Whilst these strongly-marked endowments cannot be suppressed, we often see, on the other hand, how, despite the best possible education, carefully directed towards a particular end, and although all other conditions are favourable, many persons completely fail of attainment. They fail because they lack inherited aptitudes.

It is true that defective capacities may be improved by careful training, but only to a very moderate degree. Sooner or later we reach a limit which cannot be surpassed.

Inherited tendencies are thus invariably the primary determinants for the manifestation of mental capacities.

Inheritance in the narrowest sense does not necessarily obtain as regards this development of mental capacities, inasmuch as parents and children differ in many respects. Parents with very moderate endowments may have children whose talents are altogether exceptional, whilst highly gifted parents may have offspring of mediocre capacity. But the explanations previously given show that these occurrences are by no means inconsistent with the general doctrine of heredity. The great gift possessed by one parent may be counteracted in consequence of the slight development or the absence of the like capacity in the other parent; conversely it is possible that a summation of moderate capacities in the parents may lead to the appearance of a remarkable talent in the child. We also have to take into account the possibility that the strength of the faculties in the children may be conditioned by the

state of these faculties, not only in the parents, but also in the grandparents.

Inheritance is naturally most conspicuous when we are able to note the existence of similar peculiarities in progenitors and children. Examples of such inheritance are frequently encountered in everyday life. Parents in any way distinguished very often have children with the same or similar gifts. De Candolle, among others, has studied the inheritance of certain characteristics among the elected members of the Paris Academy, individuals chosen from all countries as members of the Academy on account of their distinguished qualities. He reports five cases in which father and son were both members of this body, and quite a number of instances in which academicians had a distinguished father or a distinguished son.

To obtain a more precise understanding of such relationship it is necessary to draw up family histories, taking differential note of all those members exhibiting the distinctive qualities under consideration. Such family histories must be as complete as possible, and must extend to as many generations as possible, dealing with the two parents, the four grandparents, the eight great-grandparents, the sixteen great-great-grandparents, etc. It must deal, that is to say, with the mother's ancestors as well as with the father's. Such comprehensive family histories are termed *pedigrees,* and they comprise data relating to all the ancestors as far back as possible. Their establishment in this connexion is a recent practise. Formerly investigators were for the most part content with the so-called *genealogical trees,* starting from a single ancestor, and displaying all his descendants. If by the aid of such a genealogical tree we wish to ascertain the conditions as to the inheritance of some living member of the family, we can do this but very imperfectly, for the tree will give us the father, grandfather, great-grandfather, etc., but contains little or no information as to the ancestors of the mother, grandmother, etc. Thus the genealogical tree gives an

altogether inadequate view of the possibility of inheritance through the female members of the family. Moreover, the males of the family whose names appear in the genealogical tree are only in part those concerned in direct inheritance; the uncles, nephews, etc., of the individual whose heredity we are considering, are out of the direct line, and are of interest only to this extent, that they may afford evidence of the strength and kind of inheritance in individual generations. We may find, for example, that the grandfather is apparently healthy whilst his brothers and sisters are all diseased. In such a case it is probable that the grandfather possessed the same characteristic in a latent form. Pedigrees, therefore, are more complete and valuable statements, but we may also use genealogical trees to supplement our information.

Numerous investigations have been made with the aid of pedigrees and genealogical trees.

Galton was the first to study the inheritance of exceptional endowments, or, as he expressed it, the inheritance of genius. He examined the case of several hundred men who had attained distinction in various professions, and was able to show that in half or more of his instances these men belonged to families in which there had been other members of note, and sometimes quite a number of such. His average results were that in the case of one hundred men of genius, thirty-one had distinguished fathers, forty-one distinguished brothers, forty-eight sons of note, and in several cases three or more such near relatives attained distinction. In seventeen cases grandfathers, in eighteen uncles, in twenty-two nephews, in fourteen grandsons, were persons of conspicuous ability; while quite a number of more distant relatives exhibited marked talent. The conclusion was that high mental endowment is an inheritable family peculiarity. It appeared also that the inheritance of such qualities is conspicuous in proportion to the closeness of the relationship.

The occurrence of specialised endowments in individual

families affords us an illuminating complement to the results of such general investigations as that of Galton. For example, the genealogical tree of the Bach family shows us that its members during five generations were in many cases distinguished by notable musical capacity. In the fourth generation comes Johann Sebastian Bach, of whose eight children four exhibited exceptional musical endowment. One of his brothers, not himself musical, had six children, five of whom displayed musical talent.

Karl Pearson gives us a family tree comprising forty-eight members during five generations. Twenty-one of these exhibited exceptional gifts, some in the field of science, others in that of politics.

We have hitherto considered intellectual endowments mainly. What do we find as far as moral qualities, peculiarities of character, are concerned? The same conditions obtain; these qualities also are transmitted by inheritance. It is not necessary to discuss the matter in detail, and it will suffice to point out that already in childhood differences in hereditary moral equipment are easy to recognise. How deeply rooted in the human mind is the conviction of the heritability of moral qualities is evident in the ecclesiastical view that all men are sinful because of the sin of the first human pair, and that, as a punishment for this primal transgression, the taint of original sin has been transmitted to all descendants.

We may sum up the discussion by saying that man with all his qualities is a product of his ancestry, that he has inherited from these the rudiments of all his characteristics.

Many persons, and especially parents, are apt to exhibit a certain uneasiness in face of this conclusion. I have often heard it said that if this were true we should be forced to doubt the possibility of educating children at all. If all capacities, all characteristics, all moral qualities, are determined by inheritance, how can we hope to effect the desired results by the instruction and upbringing

of children? In answer to such a line of argument we must first of all point out that the human being simply as such, by the human nature he shares with others, is restricted in respect of the possibilities of his development. No mental capacity is capable of indefinite, of boundless increase. This fact is indisputable. When, moreover, we direct our attention to individual characteristics, no one finds that there is anything contradictory when it is pointed out that the development and the developmental capacity of all these characteristics vary extraordinarily from individual to individual. Every one knows that persons constitutionally stupid cannot become clever; that one without musical talent cannot become musical; that one whose moral equipment is primarily bad cannot be made perfectly moral. Thus we see that the unwillingness to admit the significance of heredity is motived mainly by personal interests. The parents who revolt against the foregoing conclusion desire above all that their children should possess the fullest possibilities of development, should not be fettered by inheritance. To such, as to all who have to do with the upbringing of children, we reply that inherited aptitudes are not of course to be regarded as rigid and unalterable characteristics. Sufficient stress has, on the contrary, been laid upon the fact that all aptitudes are susceptible of development. It is here that education steps in and finds a wide field for its influence. For the most part education means nothing more than the fullest possible cultivation of those pre-existing aptitudes which are good, and which will be found valuable in the subsequent course of life, and the repression of those qualities that are comparatively valueless or positively evil. By cultivation, the advantageous characteristics may often be perfected to an astonishing degree. Bad qualities, on the other hand, may be repressed, in part by instruction, and in part by the avoidance of opportunities for their exercise. Manifold experiences teach us that any faculty which is permanently put out of use undergoes gradual

atrophy. Education can obtain fruitful results on the basis of these possibilities. We must, indeed, be careful to avoid pitching our expectations too high. No amount of cultivation will improve any particular faculty beyond a certain limit which is imposed by hereditary possibilities. Certain evil tendencies we shall find it possible to repress in some degree, but never to eradicate completely. However much we may war against them, they will force themselves to the front when opportunity is given. It follows then that the matter of supreme importance is to avoid the occurrence of such opportunities.

Human beings will always remain different. There will always be individuals who are exceptionally capable, now in one direction, now in another. It is an especially important task of education to cultivate in children, and if necessary to discover, those features by which they are distinguished from others, in order to bring these to their highest possible development, even if this special cultivation does not correspond to the wishes of the parent and the teacher. Recently Ostwald, in his extraordinarily valuable book *Grosse Männer* has advocated this view. He lays great stress on the fact that precocious individuals need peculiar care, because such individuals conceal within them the potentiality of genius. We need men of genius, or to express the matter in more general terms, we need great men, men who will show us the way. We shall obtain them, not by a levelling education, not by a system which will produce as few contrasts as possible, but by one which cultivates marked aptitudes. We must create individualities which in one sphere or another will furnish us with high results or even the highest attainable to man. But every comparatively slight aptitude must also receive due attention. One only whose capacities have been developed to the fullest possible extent will be able to lead a satisfactory life. This matter will be more fully discussed in the concluding chapter.

We have now to consider the significance of human her-

edity from another aspect, I mean, as far as the behaviour of the different races of man is concerned, and that of the different varieties within the great racial subdivisions. It cannot be doubted that at the present time, at any rate, the differences between the white, yellow, and black races are no longer referable to the external conditions of life. Every race is to-day distinguished from the others by a number of altogether inalterable characteristics, characteristics which have been inherited for innumerable generations and will be inherited for innumerable generations to come. If a race be transplanted into the vital conditions of another race, its characteristics remain unaffected. This is obvious in the case of the American negroes, who have remained unchanged in their new home. The possibility is not therefore excluded of the lower races ever succeeding in attaining to the level of the higher. Distinctions that are the expression of unmistakable differences in brain structure will persist, because such peculiarities in each race will always be transmitted by inheritance. It will, certainly, remain possible for isolated individuals of a lower race to be capable of assimilating the acquirements of a higher civilisation, for among the members of the lower races, just as much as among those of the upper, hereditary capacities are variously distributed. The average level of development, however, remains below that of the higher races.

Nor can the marriage of whites with blacks effect any change here. The half-breeds, it is true, are better organised than the blacks, but worse organised than the whites. If, therefore, mixed marriages were to become the rule, the average level of humanity would sink below that of the whites. The net result, therefore, under all conditions, would be deterioration; and for this reason we must always advise against marriages between blacks and whites.

This permanence of characteristics does not merely apply to the great racial divisions, but extends also to all the varieties within those divisions. In the latter case we

have no longer or very little to do with higher or lower human groups, but either with groups which, though differing in physical qualities, are nevertheless biologically of equivalent values, or with groups whose individual mental qualities may indeed differ to some extent, but which are in essentials so similar as to appear, on the whole, competent for the discharge of the same functional activities.

We see, for example, that the individual peoples of Europe differ from one another in many respects. We are convinced that these differences are not dependent, or are not mainly dependent, upon the varying vital conditions of the respective countries, but that we have to do with characteristics which have been transmitted by inheritance for hundreds and thousands of years. The Jews afford a striking instance of such a process. Under the most diverse vital conditions, living among the most different peoples and in the most widely separated parts of the earth, they have preserved numerous characteristics unchanged for two thousand years.

What is true of the nations as a whole is true also of particular groups within these nations, for between these also differences are often plainly manifest. Thus it is easy to distinguish a Frenchman of the south from one of the north, an Irishman from an Englishman, a German of the Rhenish provinces from one of Westphalia, a Prussian in the eastern part of the kingdom from a native of German Poland, and so on. The distinction between them is based upon the differences between the hereditary characteristics which are regularly transmitted from generation to generation.

It is true that all these sub-varieties of humanity within the different countries are less sharply distinguished one from another than are the major sub-divisions of the human race, and this especially for the reason that within the limits of a single nation intermarriage is so freely effected, leading to a mingling of the distinctive charac-

ters. Moreover, such marriages are not open to the same objections as are those between blacks and whites. They may, on the contrary, have a favourable influence, because advantageous characteristics which are separate in the two varieties may be united in the offspring of the mixed marriages.

With regard to this question of mixed marriages, it is of remarkable interest that these do not always lead to an inseparable mingling of the distinctive qualities of the parents, rendering it impossible to detect these qualities separately in the offspring. This may, indeed, occasionally happen. For example, mulattoes, with a few exceptions subsequently to be considered, have a tint of skin intermediate between that of negroes and whites. Commonly, however, when human varieties intermarry, the individual characteristics appear distinctively in subsequent generations, as in the case of blond and black hair. This separation of qualities will receive detailed consideration presently.

For the present, in this connexion, we shall only refer to the fact that, in view of such experiences, an attempt has been made to demonstrate in the members of a nation or in a sub-variety of that nation the part played in earlier times by the peoples of other nations. If in the members of any nation we find physical peculiarities which do not appear to harmonise properly with its accepted historical origin, but which are regularly present in the inhabitants of some other country, we may infer that the latter at one time came into contact with the former, and took part in its genesis by way of marriage. For instance, especial attention has been directed to the manner in which the Germans have left traces among many peoples, having permeated these in popular migrations and in wars, and having to some extent settled among them. In northern Italy we not infrequently encounter persons of Germanic type (with blond hair, blue eyes, etc.), and by some the

significance of this German admixture among the inhabitants of Italy has been esteemed of very great importance. Some believe that a large number of the leading men of the Renaissance may be regarded as of German origin. It has been supposed that a similar influence can be traced in France and Spain, the indications of the admixture of German blood being fairness of skin and hair, blue eyes, great stature, etc. It is unquestionable that enthusiasts in this direction have often pushed their conclusions beyond the measure of reason, but in principle the method of investigation is a sound one.

Such deductions have been carried even further, and the attempt has been made with their assistance to analyse racial admixture within the limits of any nation, and in particular as far as the Germans are concerned. One race, the Germanic, is said to be characterised by the features just enumerated; another, the Alpine race, being distinguished by a round head, dark hair and eyes, and small stature. From the mingling of these, the population of south Germany is supposed to have originated, and in this population the characteristics of the two primary races can still be traced. It is possible to distinguish individuals who appear to belong wholly or mainly to one race or to the other. Speaking generally it is contended that the fair race is the more capable. The upper classes of the population belong predominantly to this race, the lower classes predominantly to the other. Among the lower classes, dolichocephalic or long-headed individuals again and again emerge, and work their way into the upper strata; they migrate also from the country districts, populated chiefly by the lower section of the race, into the towns, where the higher section has settled. We will not pursue these speculations further. The matter came under consideration merely in order to make it clear how far many people are willing to go in their appreciation of the phenomena of heredity.

2. *Principles of Inheritance*

In order to gain a clear understanding of heredity it is necessary to grasp the normal relationships of the process of reproduction, and a short sketch of this latter must therefore be given.

We may regard it as a matter of general knowledge that all multicellular organisms (metazoa), in contradistinction to the unicellular organisms (protozoa), are produced by germinal cells, proceeding from egg-cells or ova after these have been fertilised by sperm-cells or spermatozoa. These cells, microscopic in size, are generated in the interior of the parental body, in the reproductive glands. The female reproductive element, the ovum, continues after fertilisation and until the birth of the new individual to develop within the maternal organism, and within the embryo during this period new reproductive cells come into being.

The development of the child from the fertilised ovum will be elucidated by a simplified statement. In order to make it comprehensible to the general reader, numerous details of great interest and indispensable to a strictly scientific study of the subject must necessarily be omitted from consideration.

The ovum, consisting, like all other cells, of a cell-body and of a nucleus (the latter being composed of material similar to that of the cell-body but different in certain respects), is not susceptible of further development until after fertilisation, that is to say, after its union with the spermatozoön.

The characteristic feature of fertilisation is the penetration of the ovum by the spermatozoön. The two cells unite to form a single cell, and, above all, the two cell-nuclei coalesce to form a single nucleus. As a result of the fusion of these two cells, there comes into existence the single cell which is known as the fertilised ovum.

It is essential to recognise that the germinal cells contain within themselves, in a manner subsequently to be

explained, all the characteristics distinctive of the parental organism. Only in this way is it possible that the offspring that are produced from the germinal cells shall resemble the parents. It is obvious, however, that in the tiny germinal cells these characteristics must exist in some potential form, and that the fully developed peculiarities of the adult can only grow gradually out of these potentialities. When the two germinal cells fuse to form the fertilised ovum, the potential characteristics likewise mingle, presumably in such a way that the similar characteristics coalesce. The result is that the fertilised ovum must contain the qualities of both parents. It is commonly assumed, and the view will here be accepted, that the cell-nuclei are the real transmitters of parental characteristics, that they are in fact the immediate agents in the process of inheritance.

The ovum now begins to divide (cf. Fig. 3). As in all cases of cell-division, the nucleus divides first, by a complicated process which cannot here be described. The two halves of the divided nucleus move apart, and as this movement takes place a constriction forms round the cell between them. This process of division has been spoken of as furrowing, because a furrow forms running right round the cell, and deepens until complete separation is effected. There are now two cells, two segmentation-spheres. Development proceeds by the further subdivision of each of these, to produce four cells in all. The process is repeated again and again, giving rise by successive subdivisions to 8, 16, 32, 64 cells, and so on. Thus an agglomeration of cells is gradually formed, and by the subsequent complex transformations of this and by a continued process of cell-division the individual parts of the body and the various organs are formed. We shall not here follow these later stages of development, but shall consider the mass of cells formed by the first stages of division.

In the earliest phases of development there is thus produced a hollow sphere, the wall of which is composed of

numerous contiguous cells arranged in layers (Fig. 1). This hollow cell-sphere represents in our diagram the early stage of the embryonic organism, out of which the child will be gradually formed by a complex process of transformation. He may assume, in correspondence with what actually occurs, that upon the inner surface of the sphere, that is to say within the body cavity of the developing child, new ova (or spermatozoa) make their appearance in a manner subsequently to be described, at the spot marked E.

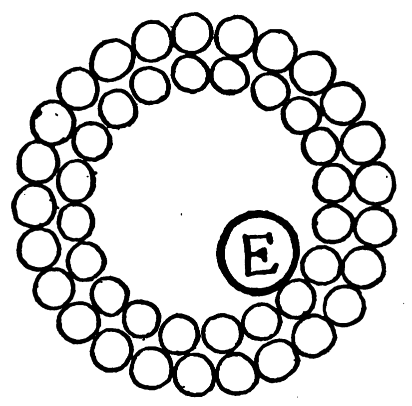


Fig. 1.—Explanation in Text.

First, however, let us reconsider the first processes of division, and the two or more segmentation-spheres formed thereby. By the study of these we can learn the following fact, which is of the utmost importance. If we separate the two first segmentation-spheres each from the other, a thing we are actually able to do only in the case of some of the lower vertebrates, such as the frog, and in invertebrate animals, and then observe how the separated cells behave, we find that each of these proceeds to divide as if it were itself a fertilised ovum, to form two, four, eight, etc., daughter-cells, so that each primary segmentation-sphere ultimately gives rise to the production of a new

individual. It results that the artificial separation of the two segmentation-spheres leads each to develop into a new living being, so that we now have two separate living beings where, had we not interfered, one only would have come into existence. This means that each of the two detached segmentation-spheres has become competent to effect that which, under normal conditions, could be effected only by the two cells in union.

No less interesting is it that the four secondary segmentation-spheres are also competent to take on the same function, though they do this less readily than the two primary segmentation-spheres. It is true that such independent development of the separated segmentation-spheres is far from being the rule, and that in many cases, indeed, they give rise to the production of only halves of individuals. But this is of comparatively small importance. For the purposes of the present argument it suffices to know that the complete development of the separated segmentation-spheres is possible.

The more advanced the process of cell-subdivision, the more remote becomes the possibility that the individual cells, if separated, will be competent to undergo an independent development; and the cells of the cell-sphere shown in the figure are not individually competent, any more than are those of the fully formed individual into which that cell-sphere will subsequently develop, to go on growing independently and to produce an entire living being. The cells, at this stage, have undergone differentiation, that is to say each cell has developed the peculiar qualities which belong to the various cells of the complete organism. Some of them have become skin cells, others brain cells, liver cells, bone cells, etc. The diagrammatic Fig. 2 is intended to represent this. The general arrangement corresponds with that seen in Fig. 1, for the same hollow cell-sphere is shown. But now the cells bear different insignia, some being marked with a cross, others with a ring, etc. Each of these insignia is intended to indicate a

particular kind of cell, those marked with a cross the skin cells, for instance, and so on.

These different kinds of cells are no longer competent, as were the first segmentation-spheres, to give rise by subdivision to all the other kinds of cells. In each kind of cell the special characteristics peculiar to that kind have come to predominate. The other characteristics are perhaps not completely wanting, but they have receded so far into the background, have been so greatly weakened,

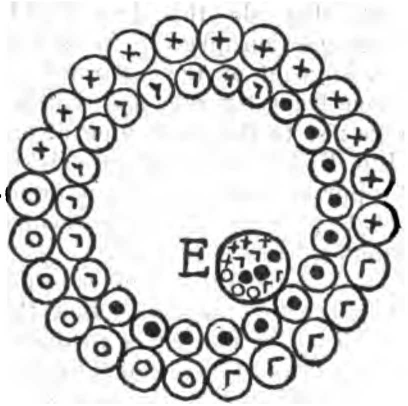


FIG. 2.—Explanation in Text.

that they are no longer effectively functional. We are led to take this view from experiments made with plants. Under favourable conditions portions of the green leaves of the begonia, containing only the cells characteristic of the leaves, may grow into a complete plant. This shows us that all the other characteristics of the plant, including the capacity to form flowers, etc., are present in the green leaves, but that in ordinary conditions they do not manifest themselves, they are latent. We are justified in assuming that in the lower animals and in man the conditions are essentially similar, but that we are no longer able to evoke similar processes of growth from the differen-

tiated animal cells. When these cells divide, they reproduce only their own kind, and never an entire organism. The ovum alone (and the first segmentation-spheres) are competent to develop into a complete individual. By this very fact the ovum is characteristically distinguished from all other cells. It is not a differentiated cell. It still contains, side by side and equivalent, all the characteristics which in the organism subsequently to be formed will be separately distributed among the various parts, and which undergo this separation during the development of the embryo. A further reference to Fig. 2 will render this clearer. In the hollow cell-sphere we observe an especially large cell, which we are to regard as an ovum. In this cell we see the same little insignia, lying side by side, which are separately inscribed on the other cells of the cell-sphere. This signifies that the qualities of the skin cells, the brain cells, the bone cells, etc., are united in the ovum; that is to say, that the same characteristics are simultaneously present in the ovum which in the developing individual (the hollow cell-sphere) have already become differentiated.

This composition of the ovum out of the individual qualities signifies that this cell, inasmuch as it is not differentiated, does not yet possess any distinctive function, has at present no specific part to play in the life of the sheltering organism. The ovum rests quietly in the organism, divides there, forming new egg-cells, but plays no part in the ordinary bodily functions. Indifferent to these functions, it awaits fertilisation and development to form a new living being.

Since, however, from this ovum there may ultimately arise a new individual, with all its peculiarities, the cell must necessarily contain within its substance, although in a manner whose nature remains unknown to us, all the rudiments of this enormous multiplicity. This is diagrammatically displayed in Fig. 2. All the characteristics present in the cells of the body are also present in the ovum. How is this possible? How do these characteristics get

into this cell? Our notions concerning heredity depend upon the answer to this question.

Let us first of all recall that in the developing individual, in the hollow cell-sphere diagrammatically represented in Figs. 1 and 2, there very soon come into existence new ova (E in the figure); these undergo multiplication as the embryo grows, and in the body of the fully formed child are found within a special organ, the ovary. How can these ova harbour within themselves such manifold peculiarities? The same question naturally applies to the case of the spermatozoa, but for the sake of simplicity we confine our consideration to the ova.

The answer to this question depends upon the manner in which the germinal cells are formed. In general terms it may be said that there are two different conceptions of this process, which we must describe in broad lines, ignoring details.

The first possibility may be expressed by saying that all the cells proceeding from the fertilised ovum and forming the developing individual (the hollow cell-sphere shown in Fig. 2) are differentiated in one direction or another. When in the embryo new germinal cells now arise this is possible only in virtue of the fact that a certain number of the cells lying in the wall of the hollow sphere lose once more all differentiation. Thus only could originate undifferentiated cells such as are the ova. In this view there first takes place a differentiation of all the cells, and there subsequently occurs a loss of differentiation of some—a roundabout way which, it must be admitted, seems rather improbable.

Nor would this be all. The mere fact that the cells which had to a certain extent become differentiated now lost their differential characteristics, would not suffice to furnish them with all the qualities which they must necessarily contain in order to give them the power of forming a new individual. For we have to remember that the loss of differentiation would give us cells simply devoid

of differential characteristics. Yet the germinal cells do in fact contain all the qualities characteristic of the parental body and of the child eventually to be developed. How do they become endowed with these characteristics?

The answer given to this question used to be that the parental body must transfer to the ovum all the characteristics. The parental body introduced them from itself and within itself into the ova or spermatozoa. To refer once more to the diagram in Fig. 2, it is supposed that all the crosses, rings, etc., which represent the characteristics are transferred from the body-cells to the ovum, so that, as the figure shows, they all become united in that cell. If this really took place the germinal cells would ultimately acquire all the peculiarities which we have to assume it to contain, and the resemblance of the offspring to the parent would thus be comprehensible.

If, however, this were a true account of the matter, we should be forced, as said above, to conceive the loss of differentiation which characterises the formation of the ova, as not merely a loss of those qualities which were distinctive of the particular cells that gave rise to the ova; we should further be compelled to assume that cells had come into being devoid of any distinctive qualities at all. For all the characteristics are to be transferred to the cell anew from the parent. But this is an inconceivable hypothesis. No cell exists which is a cell without qualification, the abstract idea of a cell. All animal and all vegetable cells possess specific qualities, for example, and at least, the qualities of the species. The cells of any species can live only in the body to which they belong. The ova themselves contain differential characteristics, even though these are not externally manifest—they possess not a few, merely, but all the characteristics of an individual. There are no cells altogether devoid of differential qualities, and it is inconceivable that in the formation of the ova there can occur an absolute loss of differentiation, that cells can come into existence which contain nothing at all.

For an additional reason this conception must be altogether excluded. The germinal cells are endowed with characteristics, not only of the parents, but also of the grandparents and of remoter ancestors. This would be impossible if in the process of their formation all their differential qualities become non-existent.

Finally, how are we to represent to our minds the process by which the parental qualities are supposed to be transferred to the undifferentiated germinal cells? Darwin assumed that from all parts of the body minute particles, termed by him "pangenes" or "gemmules," were continually being given off into the blood, and by the blood were carried to the germinal cells. But this was only a makeshift hypothesis, and it has now been generally abandoned. Nor has any better hypothesis arisen to replace it (see the next section).

We see, then, that the idea that in the genesis of the germinal cells there occurs a total loss of differential characteristics is altogether untenable.

According to this second assumption, during the development of the embryo from the ovum, while most of the cells undergo differentiation, such differentiation does not affect them all; a series of cells is supposed to remain beside, as it were, the developing individual, and preserving all the essential characteristics of the ovum. The idea is represented diagrammatically in Fig. 3. This shows us the progress of development from the single ovum a to the hollow cell-sphere e. The ovum first divides, as shown at b into two cells, at c into four, at d into many, and at e into a very large number, which form the wall of the hollow sphere. One cell, however, distinguished in the figure by vertical striation, always remains undifferentiated. First there is the ovum; then one of the two primary segmentation-spheres; then one of the four secondary segmentation-spheres; then one cell in the agglomeration d; and finally the new ovum figured in the interior of the hollow sphere e. This diagram is intended to exhibit the

fact that apart from the differentiating cells there always remains one which retains the characters of the ovum, and which ultimately becomes the ovum of the developing individual. Thus there is a continuous series from the ovum of the former to the ovum of the new living creature.

The existence of the conditions pictured in the diagram is not solely a matter of deduction. Boveri has shown in

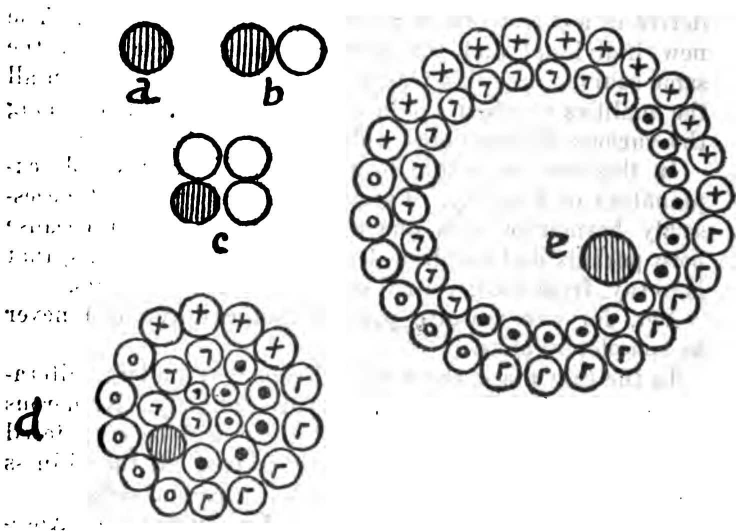


Fig. 3.—Explanation in Text.

lower animals (the roundworm of the horse) that, from the primary division of the ovum onwards through the whole course of development, it is possible to follow the growth of a definitely characterised cell-series analogous to that figured, and that it is from the elements of this cell-series that the germinal cells of the new individual subsequently proceed. This cell-series may be called the germinal series. In other animals we find more or less definite indications of an identical process, and even in human beings relevant observations have been made.

The fact that the germinal cells contain the characteristics of the parents, and therewith also those of the developing individual, no longer offers difficulties. For according to this conception of the germinal series there arise from the ovum, not only the new individual, all of whose cells are produced by cell-subdivision of the ovum, but also the new ova found in the body of this new individual, which derive in a direct line of descent from the old ovum. The new individual and the new ova thus derive from the same source. For this reason the new ova must contain all the qualities which, in the individual, are distributed among the various differentiated cells.

In this way we attain to an extraordinarily simple explanation of heredity. Parents and children must necessarily harmonise with one another in the main because both parents and children derive from the same cells, that is to say, from the germinal cells of the grandparents.

Yet, for two reasons, parents and children can never be completely alike.

In the first place, the germinal cells may undergo alteration during their sojourn in the parental body. Numerous influences may affect them, and these will be considered in the next section. Above all it is possible that illness affecting the parents may injure the germinal cells.

The second reason is one of yet wider significance. Absolute similarity between the offspring and the mother would be theoretically conceivable if the offspring were derived from the ovum alone, as happens in the case of parthenogenesis among aphides and bees. In such cases, the offspring must exhibit characteristics precisely similar to those of the mother. Parthenogenesis, however, does not take place among the vertebrata. As far as these are concerned every new individual originates out of the union of two germinal cells. In the act of fertilisation the respective qualities intermingle and must therefore manifest themselves in the offspring, although this does not mean that any simple summation takes place. For the number

of characteristics in the child is no greater than the number in the parents. Many characteristics are derived in common from both parents, while other characteristics that exist in one or other or both parents are not manifest in the offspring. In any case, the children must exhibit more or less extensive differences when compared with either parent.

Fig. 4 is a diagram to make the considerations plainer. We see first three simply planned hollow cell-spheres, A, B, C, and in the interior of these the germinal cells, a, b, c. From the germinal cell, a, fertilised at a, by conjunction with the male germinal cell derived from the individual A_1, there arises, as indicated by the line marked 2, the individual B and its germinal cell b, this latter being also connected with the germinal cell a by means of the straight line 1, 1 which traverses the whole series of individuals A, B, C. A similar succession of relationships obtains between B and C. The fertilised germinal cell b gives rise both to the individual C and to its germinal cell c. Now, since the germinal cell b possesses all its characteristics in common with the individual B, the individual C, which derives from b

Fig. 4.—Explanation in Text.

(b_1) must harmonise with B except in respect of those qualities which are derived through the act of fertilisation from B_1. B, in turn, must harmonise with A, and the same process may be followed back indefinitely into the past, and may be conceived as continuing indefinitely into the future.

In the diagram, however, the origin of the germinal cells one from another which is characteristic of the process of heredity is indicated by the straight line which connects them all. There is displayed a continuous series of germinal cells from which the isolated individuals are produced as lateral offshoots. The permanent process of heredity from one generation to another here finds characteristic expression. For this process, whose theoretical foundation we owe to Nussbaum and Weismann, and its detailed elucidation to the last-named, we possess a special name. With Weismann we speak of it as the *continuity of the germ plasm.*

3. *Occurrence in the Offspring of Qualities Acquired by the Parents* (*Inheritance of Acquired Characters*)

As regards the diffusion of diseases by way of inheritance it is of great importance to know whether morbid states acquired by the individual can be transmitted by inheritance to the offspring. If this were the rule, or if it were even a possibility, the danger of diseases getting the upper hand would be extremely great. The question must therefore be discussed, but its adequate consideration will be possible only from an extended outlook, as part of the general problem of the inheritance of acquired characters.

In the previous section an account was given of the process, in essence very simple, by which the individuals of the new generation proceed from the individuals of the old—a process that enables us to understand the observed facts as to the similarity between progenitors and offspring. We saw that from the ovum of the parent there proceeds, not

only the child, but also the ova that are found in the child's body, and that the ova in the child are in direct line of descent from the ova of the parent. From this it results that the body of the child exhibits peculiarities resembling those whose rudiments exist in the ova or spermatozoa contained within its own body. It follows, further, that when from an ovum of this child there subsequently develops a grandchild, this latter must in its turn exhibit essentially the same qualities as those exhibited by the child, now in its turn become a parent; and that, in addition, the germinal cells of the grandchild will be distinguished by the same characteristics as the grandchild itself, in consequence of which the germinal cells are enabled to transmit these characteristics to a great-grandchild, and so on.

We laid stress, however, upon the fact that whilst in this way there arises an essential coincidence of qualities in the successive generations of individuals, no perfect conformity of characters ever ensues. We showed that the principal reason for the differences observed is that the new individual proceeds from the union of two different germinal cells, and therefore contains an admixture of the characteristics of both.

An extremely interesting and important question now arises. Are the successive generations of germinal cells different merely for the reason that they have experienced the above described mingling of qualities, or may they undergo transformations, in addition, on account of the operation of external influences? In the first place we have to ask in what way such influences are able to operate upon the germinal cells. It is obvious—if we except violent mechanical injury and the like—that it is impossible for such influences to be a part of the direct working of the environment; they can act only through the intermediation of the parental body, and by inducing changes therein.

At this point we must clearly distinguish between two possibilities. Such influences as we are considering, if diffused throughout the parental body (as, for example, in

the form of some chemical agent), could exercise an influence on the parental body itself in addition to any changes they might directly induce in the germinal cells. In this case an influence would simultaneously affect the parental organism and the germinal cells, but it is clear that we could not speak of transmission from the parental organism to the germ.

The other possibility, however, does involve such transmission from the parents to the germinal cells. The problem may be stated as follows: Is it possible for changes arising in the parents, from any cause, to be transmitted as such to the germinal cells, that is, to affect these latter without further collaboration on the part of the exciting causes? Is the transmission of acquired characters to ovum or spermatozoön possible; can inheritance, in this narrower sense, take place? The question has been the subject of prolonged controversy, and has received conflicting answers. Some affirm the possibility as emphatically as others deny.

On the basis of what we have learned in the previous section a theoretical objection might be raised to the possibility of such transmission. We saw that the idea that the germinal cells derive their qualities through the access of extremely minute particles derived from all parts of the body, is one which can no longer be sustained. The qualities of the germinal cells are not dependent upon any such process, but derive from the fact that these germinal cells are the direct offspring of those of an earlier generation. This is how it is that heredity can be so simply explained. The attempt might be made to deduce from these relationships that if the characters which the parents have inherited from their parents are without influence upon the germinal cells, for this reason also those characters which have been induced in the parents by the direct operation of external noxious influences (over and above the characters acquired by inheritance) must also remain without influence upon ova and sperma-

tozoa. But this conclusion would be unsound, for there can be no doubt that under certain conditions changes in the parental body may affect the germinal cells. These cells are by no means unalterable. Indeed, thus only is the fact explicable that new inheritable diseases can come into existence. Of this much will have to be said later.

It is, then, possible that acquired states in the parents may affect the germinal cells, and it is often possible to trace the working of such influences. This, however, is not a complete answer to the question under discussion. Our true interest here is in the other problem, whether these new characters in the parent affect the germinal cells in such a way as directly to induce the formation of dispositions which will lead to the appearance of the identical characters in the individuals into which the germinal cells will subsequently develop—and not in the problem whether the ova and spermatozoa are affected in some other way than this. Such transmission of identical characters would be the inheritance of acquired characters in the strict sense of the term.

Numerous objections can be urged against the existence of any such possibility. If it were so easy for any changes in the parental body to be transmitted to the germ, we should be forced to expect that all the disturbances, grave or trifling, continually induced by external influences in the individuals of successive generations would affect the germinal cells and make their influence felt upon the offspring. Changes of all kinds, morbid conditions of the organs, injuries, etc., would necessarily have a cumulative effect, until ultimately none but abnormal and malformed individuals would ever be born. This is not the case, and it necessarily follows that the transmission to the germinal cells of changes in the parental organism is, at any rate, not the general rule.

Is such transmission theoretically conceivable? Let us try to get a clear understanding of what must happen to bring it to pass. It would be necessary for any change in

a part of the body to exercise an equivalent influence upon the germinal cell, inducing in the latter, in those constituents out of which the organ now affected in the parent is subsequently to develop, a change which, potentially speaking, must be precisely of the same character. To give an example, the skin becomes pigmented, if this colouration is to be transmitted by inheritance, it is necessary that in the rudiment of the offspring out of which the skin will ultimately arise there shall be induced a capacity for the skin to take on a dark colouration. How can this occur? What sort of relationships exist between parent and germinal cell? In the first place there is a spatial relationship, inasmuch as the germinal cell is encompassed on all sides by the constituents of the parental body. But the parts of the parental body contiguous to the germinal cell have nothing to do with the skin (or with any other organ) and therefore we cannot admit the possibility that by such contiguity the rudiment of the dark colouration can be introduced into the germinal cells. This, however, is the only direct spatial relationship. There are no nerves leading from the body of the parent into the germinal cells, and even if there were such nerves, we could not understand how changes in the organs of the parent could thereby be conducted to these cells. The only demonstrable relationship between parent and offspring is, of primary importance, that effected by the intermediation of the blood, and, of secondary importance, by the other juices of the body. Under normal conditions the constituents of the blood enter the ovum, in so far as these constituents are requisite to the nutrition of that cell. Other substances, artificially or unintentionally introduced into the body, may be found in the germinal cells, and some of these are injurious. For example, the fat-staining substance known as Soudan-red, when introduced into the organism, is found in the ova.

Thus the germinal cells may readily be influenced by chemical action. We have to ask, however, whether the

possibility of such action can explain the equivalent transmission to the germ of bodily changes in the parent. The answer to this question will become clear as we proceed.

But first let us ask what are the changes whose transmission to the offspring has been supposed to occur.

For a long time, in this connexion, people thought especially of the hereditary transmission of injuries, although the non-transmissibility of these is a matter of every-day experience. No one has ever seen a change effected by a surgical operation transmitted to the offspring. Yet again and again, in individual cases, this has been supposed possible. A few examples may be given.

Bechterew reported the case of a bitch which in early youth sustained a fracture of one of the fore-legs; this was set in a bad position, and the offspring of the animal for many generations exhibited a crookedness of one of the fore-legs. The observation, however, is altogether devoid of precision, and the accidental deformity due to the fracture is imperfectly described. No proof is given that the bitch did not previously exhibit a congenital crookedness of this leg, the inheritance of which would have been natural enough.

Another remarkable instance is reported by Lacharias. He describes tailless cats, whose mother some years before had lost her tail from injury—having been run over by a car. But there is no precise record of the injury, which, as Bonnet objected, seems rather an improbable one. It is necessary to remember that there are tailless varieties of cats, or rather cats with very short stumpy tails, and in these animals the absence of the tail is of course a hereditary character. The cats in question may have belonged to one of the tailless varieties. In dogs also, as Bonnet has shown, a similar stumpy condition of the tail is sometimes found as a hereditary character. In certain cases in which dogs had tailless offspring, and it was supposed that this was due to amputation of the tail in the parent animals, he was able to prove that the cases were actually

those of the transmission of a congenital deformity. Precise inquiry showed, moreover, that in the parent animal amputation of the tail had not been effected.

Another instance which at first sight appeared decisive as to the transmission of the effect of injury is described by Israel. A woman had an earring torn from her ear, and in her next child there was a cleft in the lobule of the ear, apparently the hereditary effect of the laceration of the mother's ear. But close examination of the mother's ear showed that in addition to the laceration resulting from the injury there existed in the lobule a congenital cleft, and that it was this that had been transmitted by inheritance.

These were mere casual observations, but certain experiments appeared to afford more weighty evidence. Brown-Séquard made an extensive series of experiments on guinea-pigs. In these animals he divided the sciatic nerve, the great nerve of the lower limb, and observed that stimulation of certain regions of the same side of the body as that on which the nerve had been divided induced convulsive seizures having a general resemblance to those characteristic of epilepsy in human beings. The observations were confirmed by numerous investigators. In the animals thus operated on, various other consequences ensued, and among these were changes in the paralysed legs, leading, for instance, to the loss of some of the toes. Brown-Séquard, and some of those who repeated his experiments, now observed that these epileptic seizures occurred in a small proportion of the offspring of the animals thus treated—in about two to three per cent. He believed himself to have proved the transmissibility by inheritance of this traumatically induced epilepsy. Sommer, however, who repeated the experiments, and Maciesza and Wrzosek, who undertook a more extensive series of investigations on the same lines, obtained completely negative results. They found themselves, therefore, unable to confirm Brown-Séquard's conclusions. But meanwhile Brown-Séquard

had reported that the secondary changes in the paralysed limbs were also occasionally transmitted by inheritance, though in from one to two per cent. only of the cases. No subsequent investigator has been able to confirm this observation. Neither Dupuis, a pupil of Brown-Séquard, nor Romanes, nor Sommer, found malformations of the feet in the offspring. Maciesza found no such changes in forty-four of the offspring of guinea-pigs with artificially abnormal legs. In addition, examining 392 guinea-pigs, he showed that malformations of the toes are found also in the offspring of normal parents in about the same proportions as in the offspring of the animals operated on by Brown-Séquard. To widen the field of investigation, Maciesza operated also on white mice, in which animals section of the sciatic nerve leads to the onset of similar deformities of the toes. The offspring of 454 mice that had been operated on numbered 1,008, and 30 of these, that is to say, about 3 per cent., exhibited malformations of the toes. Examination of the offspring of normal mice showed, however, that in these the same abnormalities were present in the same proportion of instances, so that the existence of malformation of the toes in the offspring of animals subjected to operation could not be attributed to inheritance of the results of operation.

These experiments demonstrated the unsoundness of the widely quoted conclusions of Brown-Séquard.

Weismann also obtained negative results, in a series of experiments in which he amputated the tails of mice for a number of generations. In no instances were the offspring of these animals tailless or equipped with abnormally short tails.

To-day, then, hardly any one ever alleges that the results of injury are transmitted by inheritance.

Diseases may, in this respect, be compared with injuries. Diseases may be referred to bodily changes evoked by injurious environmental influences, and may therefore, to this extent, be spoken of as injuries. It is true that dis-

eases are not usually induced by the operation of mechanical instruments, but are dependent for the most part upon chemical influences, and especially upon the toxins produced by micro-organisms. But many chemical disease-producing influences, such as corrosive acids, have effects obviously similar to those of mechanical injury. As far as these are concerned, the same considerations apply as in the case of injury. The changes they induce are not transmitted to the germinal cells. Subsequently this matter will be considered in further detail.

Here we shall refer merely to one important consideration. The anatomical disturbances, indeed, cannot be transferred to the germinal cells, but there may be a specious appearance of such a transference. When a poison affects the organism and is distributed through all its parts, some of it will necessarily reach the germinal cells, and it is possible that in these latter the poison may influence the rudiments of the very organs which in the parental body are injured in their fully developed condition. There will then ensue like changes in the parental organism and in the germinal cells, and the changes in the parental organs will appear to have been transmitted to the germinal rudiments.

Consider, for example, the influence of alcohol. In the parent it may affect the brain and in the germinal cell the brain-rudiment. In the parent alcohol may cause mental disorder, while the germinal rudiment may be injured in such a way that the child which subsequently develops has an abnormally constituted brain, and therefore suffers from mental disease similar to that which occurred in the parent. But here obviously there is no true process of inheritance; there is merely the simultaneous production of like changes in two distinct regions.

Very shortly we shall have to return to this matter, and it will be referred to again and again in our subsequent discussions.

Turning now from the consideration of the inheritance

of acquired injuries and diseases to that of the inheritance of acquired characters or qualities, we must first come to an understanding as to the precise signification of the latter term.

We must give the name of characters or qualities to such peculiarities only as attach to the healthy organism, and to such as harmonise with that organism. Injuries and diseases are not characters in the narrow sense of the term. Even if in the widest signification of the word we might speak of them as characters, we shall avoid doing so here in order that our argument may be more readily comprehensible.

The normal organism constitutes a sum of qualities harmoniously combined and in a state of mutual adaptation. Into this complex, completely new characters cannot be introduced. Such introduction is theoretically inconceivable, and is impossible in practice. When anything new is acquired we always have to do simply with a changed adaptation to foreign external conditions, with an intensification, or the reverse, of existing characters. Thus, the hairy covering of the body may become thicker in consequence of cold, or a muscle may become more powerful from exercise. The question now arises whether such acquired characters can be transmitted to the germ.

The answer to this question presupposes that we have answered another, and this is, whether the germinal cells are at all capable of being transformed in a corresponding sense. On general principles we cannot doubt that this may occur, provided that the same influence can operate upon the germ as upon the parent. When cold affects the germinal cell, the skin-rudiment in that cell will be altered in a sense identical with that in which in the parent the developed skin is altered by the same influence. Those who accept the inheritance of acquired characters must themselves admit the existence in the germinal cell of such a capacity for adaptation, for only on this assumption can the germinal cell be affected by the change that takes place

in the parental body. If, however, the germinal cell possesses a general capacity for adaptation, it must then be competent to react directly to the influence which is simultaneously acting upon the parent.

Now let us suppose, for the sake of argument, that acquired adaptations can really be transmitted. How would such adaptations make their influence felt upon the germinal cells? Certainly not by the intermediation of nerves, for there are no nerves connecting the parental body and the germinal cells. The only remaining means of influence is that of substances in solution. But how is it conceivable that substances derived from the adapted parental parts could in the rudiments in the germinal cells produce an effect identical in outcome with that which in the parent has been produced in an entirely different way, and certainly not by the substances in solution that are supposed to act upon the rudiments in the germ?

If, for example, in the parental body, a muscle undergoes enlargement in consequence of prolonged exercise, in what way could this increase in size be transmitted to the muscle-rudiment in the germinal cell? By means of the products of tissue change which are increased in quantity in consequence of the increased activity? But how could these products induce a muscular enlargement when the muscular enlargement in the parent is itself the outcome of repeated acts of contraction arising under the influence of the nervous system, and is in no way conditioned by the working of substances in solution? The strengthening of the muscle-rudiment in the germinal cell could only result from the long continuance of enhanced demands upon the activity of this rudiment, and there is here no question of anything of the kind.

In accordance with these considerations we can assume the "inheritance" of acquired characters to take place in those cases only in which the same influence is at work upon the parental organ and upon the corresponding rudiment in the germinal cell. In that case, however, we

are not concerned with inheritance in the rigid sense of the term. True inheritance would occur if the quality were transferred as such to the germ, but it does not occur when the same conditions give rise to the same result in two different places. Since such direct transference cannot be demonstrated, it follows that the inheritance of acquired characters in the strict sense does not take place. The only question open is whether we are justified in using the term inexactly to denote the simultaneous origination of like changes in the parental organism and in the germinal cell. This abuse of terminology is very common, but it would be better to avoid it, and always to insist upon the fact that what takes place in these cases is not inheritance but what may be termed *parallel induction,* that is to say, the parallel causation of the change in parent and in germ. This explanation gives full satisfaction in all the cases in which a quality arising in the parent appears also in the offspring, and in which people are accustomed (erroneously) to speak of inheritance as having taken place. It is true that many writers refuse to admit this, and many experiments have been made which are supposed to establish the direct transmission of acquired characters. We must therefore briefly consider these experimental data in order to decide whether it is really necessary to interpret them as examples of true inheritance.

Let us first consider the well known experiments of Standfuss and Fischer. These investigators reared caterpillars and pupæ of butterflies at a lower and at a higher temperature than customary, and observed that the butterflies which subsequently developed displayed abnormal colouration. Those that had been reared at lower temperatures exhibited approximations in colouring to allied forms living in cold climates, while those reared in exceptional heat resembled the allied forms inhabiting hot climates. They were able, though only in isolated cases, to show that this changed colouration was transmitted to the

following generation. Does this mean, however, that the alteration was transferred to the germ? Assuredly it has no such signification. For the pupa already contains the germinal cells of the butterfly that is subsequently to develop, and it is obvious that these cells may be influenced by the cold just as much as the entire pupa. Thereby they are altered in the same direction, and for this reason the offspring of the butterfly also exhibit the changes in colour.

In these cases, therefore, the inheritance is readily explicable through the simultaneous working of the changed temperature upon parents and germ.

Let us take another example. Mice have been bred at an abnormally high temperature (Sumner, who used a temperature of 79° F, and in other cases a temperature a little above 88° F), and it was then observed that the ears, tail, and feet were longer than normal, and more particularly that the hair became thinner. It might be supposed that in these cases also the higher temperature had influenced the germinal cells as well as the parental bodies, for the offspring of these animals, although bred at ordinary temperatures, exhibited the same changes. But in this case the explanation cannot be accepted, because the body-temperature of the parental animals exhibited no increase in the warm chambers, so that the increased temperature of the environment could not exercise any influence on the germinal cells. The animals were able to adapt themselves to the changed external conditions, and, by diminished heat-production or by increased heat-loss, they could keep their own temperature constant. How, then, are we to explain the inheritance in this case? We have first to ask how the bodily changes in question came about. It was certainly not by a direct influence of the heat upon the skin, leading to the formation of less hair, to increased growth of the tail, etc., for how could the heat bring this about? The only possible way is that the unusual heat evoked changes of some kind in the body,

changes in metabolism, and that the transformations above described were the indirect consequences of these changes. Let us recall the extent to which human beings, and therefore doubtless other animals as well, are affected by being permanently kept in a temperature of 86° F. Under such conditions we do not feel as well as usual, this showing that our whole system has been influenced in some way. There is also observed an increased redness of the skin, induced by the action of the nervous system, increased perspiration, etc. In view of these facts, we can readily understand that similar influences affecting the bodies of certain lower animals may alter the conditions of growth of the hair. If, however, these latter changes are dependent upon changes in metabolism, it is easy to understand that the chemical abnormalities in question may have a similar effect upon the germinal cells.

It seems that this explanation is not the only possible one. While actually engaged in writing this chapter I learn that in another series of experiments, in which rats were bred at a lower temperature, the animals were found to display a definite, if not extensive, depression in the body temperature. It follows that in Sumner's experiments the germinal cells may have been influenced by such a reduction in the body temperature.

In any case, in respect of these experiments, it is unnecessary to assume the direct transference of the acquired changes to the germinal cells. All that has occurred is that a simultaneous influence has been exerted by certain conditions upon the parental organism and upon the germinal cells. We do not mean that the environmental influences have directly exercised this simultaneous effect, but that changes have been induced in the metabolism of the body, and that these have operated as indirect factors of the simultaneous changes in body and germ.

Another example may be given. Kammerer made the following experiments. In one series of experiments he kept the spotted salamander for a number of years upon

a yellow ground; in another series he kept the animals upon a black ground. In the former case the yellow colouration of the salamanders became continually more widely extended, while the black colouration diminished in extent, but without disappearing altogether; in the salamanders kept upon a black ground the areas of black colouration increased. It further appeared that the offspring of the animals had undergone corresponding changes, those of the yellower salamanders being much yellower than usual, and those of the blacker salamanders much blacker. It is obvious, however, that the yellow or black ground cannot be supposed directly responsible for the transformation in the skin, for this is the result of an internal modification in the animal, induced by the change in the illumination. On the lighter ground, there is more light to influence the animal than upon the darker ground. The internal change thus induced, chemical in nature, is competent at the same time to affect the skin and change its colour, and to influence the germinal cells in a like sense. As has recently been shown, it is also possible that the stronger illumination penetrates to the germinal cells, having the same effect in them as in the body. The influence of the weaker illumination upon the darker ground naturally finds a similar explanation.

Again, Kammerer made remarkable experiments with the accoucheur toad. In these creatures the male, living on land, wraps the fertilised ova of the female, filiform in shape and ranged side by side, round his hind legs, and carries them about with him for a time, until the young are so far developed that when the male now enters the water, they emerge as tadpoles and undergo their further development in the free state. But if the females were kept at a higher temperature and in a drier atmosphere than customary, they proceeded to deposit their eggs in the water, and the eggs could no longer be carried about by the male, for their development was accelerated under the influence of the water, and the young animals very speed-

ily emerged. After this had happened for several generations, the offspring, even when not kept at an enhanced temperature, went straight to the water when sexually mature and laid their eggs there. At first sight it might seem as if the changed custom had been inherited. But it is easy to see that nothing of the kind had really taken place. The changed conditions have a primary influence upon the eggs laid in the water, and from these eggs are derived, not only the new generation of animals, but the germinal cells originating in the bodies of these. In such conditions the habituation to the water has its effect upon the germinal cells as well as upon the young toads.

A general account has now been given of the experimental evidence as yet available bearing upon the problem of the inheritance of acquired characters. It has been shown how extraordinarily difficult it is to arrive at any decisive conclusion upon this question. This much, however, is certain, that no one has hitherto succeeded in proving that acquired characters can be directly transferred as such to the germ. There is no evidence that from the changed organ something is given off which can enter the germ and induce therein a corresponding change, or that by any other process the acquired character can directly or indirectly influence the germ. On these grounds we can affirm to-day that the inheritance of acquired changes does not occur.

On the other hand, however, it is a well-established fact that in many instances characters which first made their appearance in the parent are to be found in the offspring. In such cases, there is no inheritance in the strict sense of the term. What happens is that in one way or another the change is simultaneously induced in the parental body and in the germinal cells which it contains, so that the respective changes arise independently. This is possible in two different ways. A change-inducing influence invading the body may directly influence the germ as well, as happens in the case of alcohol and of Röntgen rays. On the

other hand, the environmental influence may first induce some modification in the body, a change in some vital process, and this may affect some particular part of the parental body, giving rise to the acquirement of a new character, and simultaneously may influence the germ by inducing a corresponding change in the rudiment of the same organ that is affected in the parent. This process is known as parallel induction.

It might be supposed a matter of practical indifference whether the appearance in the offspring of a character acquired by the parent be due to direct transmission, or whether it be due to an equivalent influence exercised upon parent and upon germ. As far as the individual child is concerned, the distinction is certainly of no moment. If, however, we wish to obtain precise ideas about heredity, and if we wish to be able to decide in individual cases whether an acquired character may be expected to be reproduced in the offspring, the distinction is one of very great importance.

On this assumption of a simultaneous influence on parent and child, we understand without further argument that the effects of injury and many diseases cannot be transmissible by inheritance. As regards injury, it is clear that in the germinal cells an equivalent injury to that suffered by the parent could only be effected by an identical influence exercised upon the rudiment of the organ concerned. For example, amputation of a limb in the parent could lead to the absence of the same limb in the child only by the removal of that portion of the germinal cell out of which the limb is destined to develop. For it is inconceivable that the absence of a limb could *per se* exercise such an influence upon the germ.

Further, it is easy to understand that of acquired characters, in the narrower sense, many cannot be reproduced in the offspring. To give particular examples, the acquired enlargement of an athlete's muscles, which often attain to an astonishing size, is not transmissible to the

offspring. Such muscular enlargement is the outcome of voluntary action, operating by way of the peripheral nerves, whereby the muscles are repeatedly and powerfully set in action. In the germinal cells, a strengthening of the muscle-rudiment could be effected only by exercise—a condition obviously impossible to fulfil. Again, it is impossible for the increase of any mental capacity to be associated with a corresponding increase of energy in the appropriate germinal rudiment. We may calculate the individual as much as we please in any direction, musical, mathematical, scientific, or ethical, but this will never exercise any such influence upon the germ that the individual subsequently developing from that germ will display in consequence an increase in the capacity that has been especially cultivated by the parent. Technical capacities again, such as the specialised manual dexterity of the pianist, or the aptitude for various handicrafts acquired by skilled workmen, have to be reacquired by the offspring, for they are not transmitted by inheritance. Indeed, the fact is obvious. How could we otherwise explain why it is that parents who have specially trained their faculties in some particular direction may have children who display no conspicuous ability along the same lines? Where children display from youth upwards faculties similar to those for which their parents have been distinguished, we are compelled to assume, in the light of the present argument, that they were primarily endowed in the germ with the rudiments of the same faculties, and that there has not been transmission of an acquired character from the parent.

In discussions of the theory of evolution the question has been mooted of the transmission from parents to offspring of qualities developed by practice—of their transmission as functional adaptations. It has been assumed that individual adaptations to new conditions can be transmitted by inheritance. Here again, however, it is our opinion that in all the cases in which the adaptation arises

directly or through the intermediation of the nervous system, in all those, that is to say, which are not the outcome of any chemical change affecting the body as a whole, the reappearance of the adaptation in the offspring, its transmission by "inheritance," is excluded. Only when the external influence leads to a change in metabolism, when this leads to the adaptation, and when the primary change in metabolism is competent to exert an identical influence upon the germinal cells, is it possible for the adaptation to be transmitted to the offspring.

We see, then, that the appearance in the offspring of qualities acquired by the parents is limited to the case of those changes in which it is possible for the parental body and the germinal cells to be simultaneously influenced, or in which a modification induced in the parental organism is the cause of the appearance of the new quality, and the modification in question exercises the like influence upon the germ. In both these cases we have to do with parallel induction, and not with manifestations of heredity in the strict sense of the term. The advocates of the view that acquired characters are inherited may very well be satisfied with these admissions, for even though acquired characters are not inherited in the sense formerly believed, and still believed by many to-day, it remains an indisputable fact that many changes acquired by the parents do actually reappear in the offspring.

4. *Diseases Affecting the Parents and Recurring in the Children ("Hereditary" Diseases)*

We showed in the first chapter that every morbid state is characterised by a diminution in functional capacity, at first of individual organs, and ultimately of the body as a whole. This impairment of functional activity is dependent upon anatomical changes in the organs, and these changes are in their turn induced by manifold injurious

influences (poisons, micro-organisms, etc.). We are thus led to define disease as the sum-total of the depressions in the vital processes resulting from alterations in the structure of the body.

In our consideration of the "inheritance of diseases" we must start from this definition, for it is obvious at the outset that no hereditary transmission occurs in the case of the depression in functional activity.

It is impossible that this depression should be inherited, if only for the reason that the germinal cells do not as yet contain any functioning organs, organs whose functions are capable of being disordered; and in addition we have to remember that depression in functional activity is not a process existing *per se*, but is one dependent upon the anatomical structure of the organ whose function is affected. All that is possible is for the germs to be influenced through the occurrence of changes in the individual rudiments out of which will subsequently develop organs corresponding with those now diseased in the parent—the changes being of such a nature that, owing to the abnormality of the rudiments, it will result in the offspring that alterations in the organs will appear corresponding with those which have now appeared in the parent. Then the offspring will display the same morbid phenomena as the progenitor. It follows that when we speak of the "inheritance of diseases" we mean no more than this, that in the child like anatomical changes are found that were found in the parent, and that in both individuals these changes induce like morbid phenomena. Hence it would be better to speak of the inheritance of the anatomical changes. Indeed, even the terms "inheritance" and "hereditary transmission" are open to objection, for their strict significance is, in this connexion, that the anatomical changes are transmitted from the parents to the offspring, and this idea, as we have seen before and shall see again, does not correspond with the facts of the case. The only perfectly objective method of expression is to say that off-

spring and parent manifest like anatomical changes, and that these induce like morbid phenomena in both. The use of the terms "inheritance" and "hereditary transmission" has, however, become habitual, and no objection need be raised to this usage provided we understand clearly what we mean. But we must never lose sight of two facts: first of all, that no inheritance really occurs in the rigid sense of that word; and secondly, that when we speak of inheritance we refer only to the "inheritance" or "hereditary transmission" of the anatomical changes, and not of the actual diseases. In the discussions which follow it is this that we shall always mean when for the sake of brevity we speak of the "inheritance of diseases."

The actual method by which the morbid disposition is transmitted from parent to offspring will be considered in a subsequent section. It is our present concern to learn what are the diseases transmissible by inheritance. They are numerous, though less numerous than is currently supposed. In many cases in which people speak of the inheritance of disease this has not occurred in the sense above defined, for inheritance is merely simulated. What occurs is not that anatomical changes corresponding with those that induce the disease in the parent affect the germinal cells, and consequently recur in the offspring, but that the injurious influence which leads in the parent to the morbid change in question is itself transferred to the offspring, and in the germ and in the offspring itself induces like changes. To make this distinction clear we must briefly recur to the considerations detailed in an earlier section (p. 69) as to the appearance of diseases in the offspring.

Simulated inheritance occurs in the case of certain diseases induced by micro-organisms. The most important of these is tuberculosis, and to this illness we shall now limit the discussion, for the considerations that apply here are readily applicable to other infectious diseases. In all the infectious diseases in which a simulated inheritance takes

place, what in truth happens is that the living organisms which are the exciters of disease pass from the parent to the germ or to the offspring and thus induce disease in the latter. All that really takes place is an infection of the germ.

We learned first of all (p. 72) that in very rare instances tubercle bacilli may penetrate the ovum, which nevertheless, as is proved by experiments on birds, remains capable of development. When, in such cases, the offspring are diseased it seems at first sight as if the tuberculous processes had been transmitted by inheritance, whereas really the germ has not undergone any corresponding changes, but merely contains the tubercle bacilli, whose subsequent development in the child gives rise to tuberculous processes.

Similar erroneous conclusions are apt to be drawn in the commoner cases in which the body of the developing child is invaded by tubercle bacilli derived from the maternal body by way of the placenta. In these cases also inheritance is simulated; whilst the actual process is one of consecutive infection.

Tuberculous changes as such cannot possibly be transmitted, for they are induced solely by the action of tubercle bacilli, and are inconceivable in default of this action.

The second way in which a false impression may arise is that when tuberculosis occurs in the offspring what has been transmitted from the parents may be nothing more than a peculiar susceptibility to the bacillary infection. If in such cases the offspring are for any reason (see p. 73) attacked by the bacilli, the micro-organisms, finding a suitable soil, may often induce severe tuberculous disease in several children of the same family, and these children are then supposed to suffer from inherited tuberculosis. In such cases what has been transmitted is a predisposition to tuberculosis, a predisposition which does not *per se* induce the disease, and whose existence, in many cases, does not lead to any impairment of health.

The offspring may, in the third place, be infected when no inherited predisposition to tuberculosis exists. All human beings are susceptible to this bacillary invasion to a greater or less degree, although in some the susceptibility is so slight that they never become seriously ill. Those children in whose bodies the bacilli are able to flourish, if invaded by large numbers of the micro-organisms, as is especially liable to happen in the children of tuberculous parents, are apt to become tuberculous although there is, in these cases, absolutely no hereditary factor in the causation of the disease. But since, in such cases, the true origin of the illness may easily be overlooked, it is often erroneously assumed that the disease is the outcome of heredity.

We thus see that there is a series of possibilities whereby heredity may be simulated, so that we are led to regard the number of inheritable diseases as being even greater than it really is.

If we turn to consider the cases that actually belong to the hereditary category, we must first point out that we speak here only of illnesses in the strict sense of the term. Heredity also plays a part in the production of a great series of bodily changes which do not lead to a depression of the functional activity of any organ or to a disturbance of the general sense of wellbeing. Above all, we have to think in this connexion of many malformations which, although they naturally impair the functions of the affected organs, need not seriously impair the vital capacity of the individual, and may leave it altogether unaffected.

These malformations cannot be left out of account, in part because they may lead to the occurrence of morbid manifestations, and in part because they furnish us with extremely characteristic examples of the working of heredity.

It is desirable to classify inheritable morbid states in a number of groups, arranged either in accordance with the changes affecting particular organic systems, or else in

accordance with certain peculiarities of the phenomena of inheritance, a knowledge of which is of great importance to our subject. In the theory of hereditary transmission, and also from the practical point of view, we are greatly concerned to know whether diseases are transmitted directly from one generation to the next, or whether one or more generations may remain exempt; whether they invariably affect all the offspring, or some only; whether, in the latter case, the healthy and the diseased children are distributed in accordance with definite rules; whether the marriage of near kin and the transmission of taint from diseased ancestors play a part; and so on. In the present section we shall touch on these matters only in passing, but they will subsequently be considered in further detail.

We will speak first of a group of illnesses in which the morbid heredity is characterised by the fact that the female members of the family themselves remain nearly or completely free from the disease, but transmit to their sons the morbid taint they have themselves derived from their fathers. Of course this is possible only when the women, although they do not themselves suffer from the disease, have latent in their germinal cells, in their ova, changes corresponding to the disease they transmit. The male members of the family, who need not in all cases themselves actually suffer from the disease, transmit it, not to their sons, but to their grandsons, through the intermediation of their daughters.

The best example of heredity of this type is afforded by the disease known as hemophilia, or the hemorrhagic diathesis, a morbid condition characterised by the peculiarity that wounds, or even very trifling wounds, are apt to lead to serious and it may be fatal loss of blood. The actual determining cause of the excessive bleeding is not fully understood; but it appears probable that the trouble is dependent upon deficient coagulability of the blood, in

consequence of which the cut or lacerated blood-vessels are not closed quickly enough by blood-clots.

In a small percentage of instances women are also affected with the disease, but some investigators dispute this assertion, contending that the cases in which women have appeared to be "bleeders" can be explained in some other way.

Hemophilia is not a common disease, but it has received especial attention owing to its striking and alarming consequences. This explains why, in their *Treasury of Human Inheritance,* Bullock and Fildes were able to give two hundred and forty genealogical trees of bleeder families, trees varying greatly in comprehensiveness. In rare instances only has the course of such families been followed for so many generations as in the case of the bleeders of Tenna and in that of the Mampel family. Tenna is a village in the Swiss canton of Grisons. The reports of the bleeders in this locality go back to the end of the seventeenth century, and comprise seven generations. E. Zahn makes this family history the foundation of his novel *Die Frauen von Tannó.*

The Mampel family, whose records were last examined by Lossen, comprised 217 members. Of the 121 males, 37 were bleeders; the 97 women were all exempt.

A remarkable peculiarity of bleeder families, and one to which we shall return, is their exceptional fertility, accompanied by an exceptionally high child mortality.

Another morbid condition, transmitted in a singular way to hemophilia, is colour-blindness, the sufferers from which are either totally unable to distinguish colours, or confuse certain colours, and especially red and green. We have numerous genealogical trees displaying the incidence of colour-blindness. In these, the proportion of women affected with the disease is somewhat variable, but on the average we find 15 men suffering from colour-blindness for every one woman similarly affected.

Exemption of the female members in affected families

is also observed in hemeralopia, or night-blindness, which however is usually transmitted by direct inheritance (see the next group). Those suffering from night-blindness see very badly in twilight and in moonlight.

As regards progressive muscular atrophy, a case has also been recorded in which inheritance took place on similar lines. But here, too, direct inheritance is the rule.

In the case, on the other hand, of a large proportion of

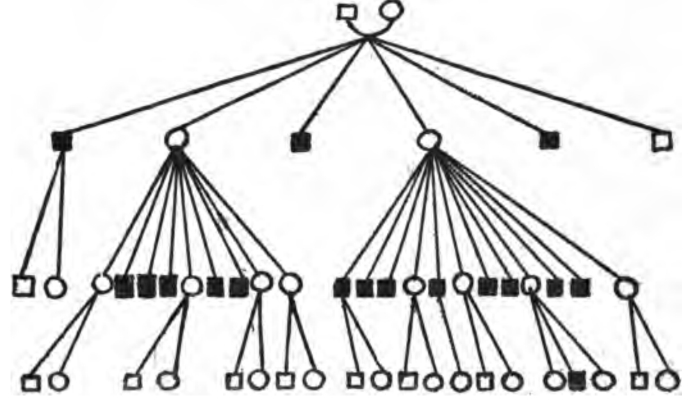


FIG. 5.—Genealogical Tree of the Mampel family of bleeders (after Lossen). The circles indicate the female and the squares the male members of the family. The black squares denote the bleeders.

the families affected with congenital optic atrophy (optic neuritis), exemption of the female members from the disease has been observed, while they transmit it to their sons; but in some of the families with this morbid inheritance, a small percentage of the female members themselves suffer from the disease.

The explanation of this peculiar form of inheritance is far from easy, and the question is certainly too difficult for discussion here.

In a second group of illnesses, we find a certain number of examples of direct inheritance (inheritance, that is

to say, without skipping a generation), in which the morbid manifestations appear alike in male and female members of the family, and may be transmitted by these to both sexes in the next generation. It is, however, very important to note that the morbid heredity does not affect all the children, but only about one half of these, and this matter must be considered more fully in the next section. In these cases, if the child of a diseased parent remains exempt from the disease, the morbid heredity is interrupted at this point, for the offspring of this child are also free from the taint.

A very characteristic and unusually comprehensive example is afforded by the celebrated family history studied by Nettleship. Here the incidence of night-blindness in the Nougaret family is recorded for ten generations, the records beginning with the year 1637. Reports are available regarding 2,116 members of this family, of whom 135 suffered from night-blindness, the cases being distributed among males and females in about equal proportions.

In a case of malformation of the fingers reported by Farabee the inheritance of the affection took a similar course. The fingers contained two phalanges only. The anomaly was transmitted to one half the children of both sexes, and the offspring of the normal individuals remained unaffected.

The same course of heredity has been observed in cases of congenital cataract.

The third group of affections comprises the congenital malformations: hare-lip, polydactyly, the so-called cleft-hand and other developmental abnormalities of the hand, web-toes, a case of absence of the sweat-glands. Here inheritance is often direct, but in different branches of the same family the malformation may appear in children whose parents are themselves exempt. This is explicable on the ground that the grandparents or remote progenitors were affected with the anomaly, which has remained latent in all or some of the members of one or more generations.

A fourth group consists of a number of affections of the skin. First of all must be mentioned tylosis palmaris, an irregular thickening of the skin of the palms of the hands and the soles of the feet. Cases have been recorded in which this affection was markedly hereditary. To the same group belongs albinism, characterised by an absence of pigment from the skin, varying greatly in extent, in the form of pigment-free macules isolated or in groups on certain preferred parts of the body. The condition is naturally most conspicuous in the coloured races, and here, by contrast, the pigment-free macules appear perfectly white. In a monograph on the subject by Karl Pearson and others, a case is recorded in which the anomaly was transmitted for five generations. In one of these generations, consisting of six children, three only were affected. To this case, and to another of the kind, we shall recur in the following chapter. We must also mention here the condition known as onychogryphosis, a claw-like formation of the nails of the fingers and toes, which in one case has been observed in brothers and sisters, the mother, a daughter, and a granddaughter; hypertrichosis, an excessive growth of the hair, as seen in the so-called "hairy men" and "hairy women"; hypotrichosis, or deficient growth of the hair, to be considered later; a skin-disease known as psoriasis; and finally xeroderma pigmentosum, to which also we shall return.

In a fifth group, we find certain inheritable anomalies of the eyes, including congenital opacity of the cornea, shortsightedness, pigmentary atrophy of the retina, glaucoma, and two conditions to which reference has been made above, congenital cataract and colour-blindness.

A sixth group comprises affections of the nervous system. To this category belong hysteria, neurasthenia, wordblindness, Huntington's chorea, hereditary ataxia, congenital myotonia, and trophic edema—diseases some of which are so exceedingly rare that it is needless here to do more than mention their names. More important is the hereditary

transmission of deafmutism, of which numerous instances are recorded, and which may appear in certain families with extraordinary frequency. The work previously quoted, *A Treasury of Human Inheritance,* gives a genealogical tree of 83 members, of which 53 were deafmutes. Mental disorders are often encountered in association with deafmutism, a matter to be discussed presently. It must also be noted that in the families in which deafmutism is prevalent, the marriage of near kin is of common occurrence. To this we shall return. Among the inheritable diseases of the nervous system must finally be mentioned tetany.

We come now to the seventh group, one of especial importance, that of the mental disorders. In these, as every layman knows, heredity plays a great part. The alienist, when examining his patients, never fails to enquire about hereditary taint, and it is therefore not surprising that we should possess numerous detailed and characteristic studies of the inheritance of mental disorders, illustrated by genealogical trees. A few examples may be given. A well-known instance is that of the family Zero, which lived in a secluded Alpine valley. The founder of the family sprang from progenitors not known to be affected with mental disorder, but was an alcoholic. He married a woman belonging to a family of Italian vagrants who traded in tinkers' wares. This was in the beginning of the 17th century, and among their numerous descendants normal individuals were altogether exceptional. In many families, indeed, there was not to be found a single normal member. In a number of cases a considerable portion of the offspring died in childhood. The manifestations of mental disorder were very variable. Some were alcoholics; especially common were asocial individuals, persons unable to adapt themselves to the normal conditions of social life; there were criminals (sometimes exhibiting marked mental disorder), imbeciles, idiots, cripples, mental invalids of various kinds. In some branches of the family, those with

conspicuous mental disorder predominated; in others, the asocial types. The founder of the family had a brother and several cousins who were themselves normal and who married normal wives. The offspring of these marriages were perfectly healthy.

As far as mental disorders are concerned, the heredity of these is greatly aggravated by intermarriage between closely connected families, or between those affected with like taint. This matter will require further attention. We possess a genealogical tree showing that the parents of a woman suffering from mental disorder were themselves mentally abnormal. They were not blood-relatives, but the families of both had exhibited hereditary taint for several generations. In the mother's case this taint was especially severe. She herself was mentally abnormal, and drank to excess; her father was a drinker, and her paternal grandfather a drinker who committed suicide. This grandfather had seven children, two of whom died in infancy, while the others were all abnormal.

Another genealogical tree deals chiefly with the hereditary transmission of epileptic states of varying severity, associated in some cases with more or less pronounced mental disorder. A marriage took place between first cousins, both of whom were themselves abnormal, while the wife's parents were epileptic. This pair had six children, of whom some were eccentric, some affected with epilepsy and mental disorder, and some exhibited bodily deficiencies. In another branch of the same family, in which in the course of five generations marriages between cousins took place five times, there occurred such an accumulation of epileptic taint that the six children of the third generation were all epileptics.

An eighth group of inheritable affections comprises the well-known disorders of metabolism, gout, obesity, and diabetes. As regards the last-named, in especial, we have genealogical trees showing that among the offspring of diabetics a proportion only, and often not more than half,

are diseased. To this point we shall return in the next section.

To a ninth group belong the inheritable tumours, among which must be included the so-called nemofibromata, multiple enchondromata and bony tumours, fatty tumours, congenital malignant tumours of the eye, and to a minor degree also cancer (carcinoma). So far as we possess sufficient observations, it appears that inheritance in these cases is usually direct. What is transmitted, however, is not the tumour as such, but probably certain disturbances in the development of the embryo which at some subsequent period of life lead to the appearance of the new growth.

In a tenth and last group may be classed certain diseases which are unrelated, and whose only common link is that they are all transmissible by inheritance. These are polyaria (diabetes insipidus), characterised by the evacuation of excessive quantities of urine, alcaptonuria (which will be considered in the following section), cretinism, eosinophilia (a disease characterised by abnormal behaviour of the white blood-corpuscles), and certain diseases of the blood-vessels (the so-called calcareous degeneration of the arteries, and the tendency of the veins to undergo abnormal enlargement leading to the formation of piles and varices).

This concludes our general sketch of the diseases transmissible by inheritance. The mode of transmission has already been partially discussed, and will be further considered in the sequel.

5. *Rules in Accordance with Which Diseases Affecting the Parents Make Their Appearance in the Children*

In the previous section, and also in the sixth chapter, reference was made to the fact that hereditary diseases do not usually appear in all the offspring of affected persons; and that, further, whole generations may be skipped, so

that while the children themselves remain healthy the disease may be inherited by the grandchildren. How are such exemptions possible?

When parents are affected with some abnormal condition, it might appear at first sight that if the changes were present in the germinal cells at all they would be present in all of these, so that all the offspring of the affected parents would necessarily suffer from the disease. The first and most obvious objection to such a notion is this, that the conjugation of a diseased germinal cell with a healthy one may result in the suppression of the morbid character by the normal, so that the offspring will remain healthy. There can be no doubt that such a process plays a part in producing exemption, but we are hardly justified in assuming that herein lies the sole explanation that some of the children almost invariably escape.

There is another explanation which brings us much closer to the facts. We need merely assume that not all the germinal cells of a diseased parent need necessarily be affected. But how can this be?

In certain cases the exemption of some of the offspring may be supposed to depend upon this, that the injurious influence which gave rise to the change in the germinal cells had not yet come into operation at the time when the first members of the family were procreated. If we think, for example, of chronic alcoholic intoxication, we shall recall that a man or a woman may not take to drink until some time after marriage. The first children would then be healthy, and all the later ones diseased. But such occurrences are exceptional, and as a rule we cannot demonstrate that exemption takes this course. Healthy and diseased children often alternate, though the alternation is not necessarily a regular one.

Another explanation that has been offered, to the effect that the injurious influences operating on the reproduction glands have been brought to bear on some only of the germinal cells, while others have remained exempt from

the influences, is inacceptable. The conditions of existence of the germinal cells within the reproductive glands are in the main identical, and we cannot conceive how a portion of the cells, say a half of these, could escape when the others were injured.

Moreover, both the interpretations last suggested are applicable to those diseases only which first make their appearance in the body functionally competent for reproduction, and have no bearing upon the origin of those diseases which derive from earlier generations. When a human being inherits a disease, we seem at first sight forced to assume that all his germinal cells will also be affected, in the absence of special conditions leading to the exemption of some of these cells. For, as we showed on p. 104, the germinal cells as well as the individual within whose body they are found are derived from the same diseased germinal cell of the parent. But if all the germinal cells are affected, all the offspring must be diseased. Since some of the offspring remain exempt, we are logically forced to infer that a portion of the germinal cells has remained healthy. How can this be explained? The following considerations will render the matter intelligible. We may conceive that in the process of fertilisation a diseased germinal cell unites with a healthy one, and that in the conjunction between the altered organ-rudiment of one cell and the normal organ-rudiment of the other there is not produced an inseparable unity, but that both the organ-rudiments, the altered and the normal, remain side by side but distinct in the primary germinal cells of the child that proceed from the fertilised ovum. We must further assume that in the formation of the ova or spermatozoa that are ultimately derived from these primary germinal cells, the two distinct rudiments separate each from the other, so that there are now produced certain ova (or spermatozoa) affected with the alteration, and certain others that are exempt from it. In that case, some of the children proceeding from these cells would be healthy, and

some of them would be diseased, in about equal proportions.

These considerations are not based solely upon theoretical deductions. They appear to be justified by the experiments which have of late years been carried on on the lines laid down by Mendel, and they form an essential part of the doctrine known as Mendelism. We cannot consider Mendelism in detail, but it is necessary to our argument that we should give a brief summary of its most important data.[1]

As Mendel showed, if we cross certain plants of the same species, one variety bearing red flowers and the other white, in many instances the result is one which is of especial interest to us here, namely that all the offspring in the first generation have red flowers. The red colour is then said to *dominate* the white, the bearing of red flowers is called a *dominant character*. If the red-flowering plants of this first generation are now allowed to interbreed, we find that 75 per cent. of the next generation have red flowers and 25 per cent. white. There has thus occurred in the second generation a *segregation* of characters; the red-flowering and white-flowering tendencies, which were combined in the red-flowering plants of the previous generation, have separated again. This is not difficult to comprehend, but how can we explain the percentage distribution? In order to understand this we must get a clear idea of the relationships that obtain in connexion with the segregation. The plants of the original red-flowering variety produced germinal cells containing only a red-flowering rudiment, while the plants of the white-flowering variety produced germinal cells containing only a white-flowering rudiment; or, to condense the expression, the former have red germs only, the latter nothing but white. When the

[1] For the detailed study of this subject consult Bateson, *Mendel's Principles of Heredity*, 1909, and Punnett's *Mendelism*, 1911. Recent German authorities are: Haecker, *Allgemeine Vererbungslehre*, 1911; Goldschmidt, *Einführung in die Vererbungswissenschaft*, 1911.

plants are crossed, in the act of fertilisation a red germ unites in every case with a white germ, and since the red germ is dominant, all the plants of the next generation are red. The germinal cells of the red plants, however, at the time when these cells begin to be formed, contain both red and white rudiments, each germ is constructed out of red and white. When, subsequently, the true male and female reproductive cells proceed from these primary germinal cells, a segregation of the red and white characters ensues, so that there arise germs which are all monochrome, red germs and white germs in equal numbers. In order to make it clear how the percentage of red-flowering and white-flowering plants comes to be that above described, the following assumption is necessary. In the crossing of the monochrome germs (some white and others red) of the red plants of the first generation, one fourth of the red female germinal cells combined with one fourth of the red male germinal cells to give rise to red-flowering plants, and one fourth of the white-flowering female germinal cells united also with one fourth of the white male germinal cells to produce white-flowering plants. The remaining 50 per cent. of the germs united in such a way that in each case a red and a white germ effected conjugation, and the result of these unions, since the red character is dominant, was to produce red plants only. The total outcome, therefore, is 75 per cent. of red-flowering and 25 per cent. of white-flowering plants.

If the first mentioned 25 per cent. red-flowering plants of the second generation now breed only with one another, the outcome of these unions, since the plants in question possess nothing but red germs—for they were produced by the conjugation of a red male with a red female germinal cell—is red-flowering plants and nothing else. For the same reason, the 25 per cent. of white-flowering plants when these are bred true, produce in the next generation white-flowering plants only. The 50 per cent. red-flowering plants, however, which proceeded from the union of

red and white germs, and which flower red because the red character is dominant, will, if bred true, produce the same sort of offspring as did the red plants that were the outcome of the first crossing, namely 75 per cent. red-flowering and 25 per cent. white-flowering.

A study of Fig. 6 should make what has just been said somewhat clearer. The large circles represent the fully developed plants, the small ones germinal cells. The vertical striation indicates the red colour. At F we see a striated (red) and a white plant, side by side. Each contains an appropriate germinal cell. At a these cells conjugate. From the results of conjugation there proceed at b new germinal cells, of which each has half only striated to show that it is a composite of red and white. From these germs there arise at c new individuals (comprising the first daughter - generation F_1), which are striated (red) because red is dominant. Within these new individuals we see at d that new germs have been formed in which separation of the colours has occurred, so that half of them are red and half white. We show in the diagram four germs in each individual. At e conjugation takes place, the red and the white germs from the respective individuals encountering one another in ways imposed by their respective members. The result of the four acts of conjugation is to give rise to four new plants of the second daughter-gen-

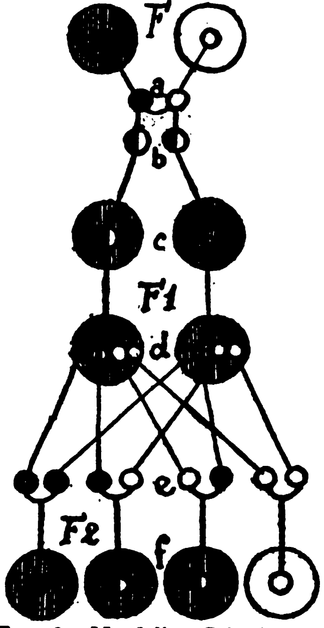


FIG. 6.—Mendelian Inheritance. Explanation in Text.

eration F_2, three of these being red and one white. One of the red individuals has red germs only; the other two red individuals have red-white germs (as at b and c).

What has been said of red and white applies, *mutatis mutandis,* to other characters, such as the shape of the leaves, the size of the seeds, etc. Two such different characters may unite just as do the colours, and may then undergo segregation in the same percentage relationships as did these. What occurs in respect of normal qualities is also conceivable as regards the union between a healthy quality and the corresponding pathological quality. In the latter case, also, it is conceivable that if the illness be a dominant character, 75 per cent. of the offspring will be diseased and 25 per cent. healthy.

Bearing on pathology another experiment is of interest. If the red-flowering plants of the first generation are crossed with pure white-flowering plants, that is to say, with plants whose germs are all white, half of the resulting offspring are white and half are red. The explanation of this is simple. As we showed above, one half of the germs contained by the red-flowering plants are red and the other half are white, but all the germs contained by the white-flowering plants are white. In the process of fertilisation, every red germ unites with a white germ from the other plant, and since red is a dominant character, the offspring of these unions are all red. The white germs of the red-flowering plants, on the other hand, unite with white germs from the other plant, and the offspring of these unions are naturally white.

These results also are applicable to the case of disease. When diseased individuals unite with healthy ones in the act of procreation, it may happen, if the disease is a dominant character, that all the offspring are diseased. Within these individual offspring, however, there may be produced, by a process of segregation, both diseased and healthy germs; and if the individual whose body contains these germs unites in marriage with a healthy person, of the

offspring of this pair one half only will manifest the disease, while the other half will remain healthy.

The separation of the healthy rudiment from the abnormal is easier to understand than that of the rudiments of the red and the white colouration, or those of other physiological qualities. For, as regards these latter. it is conceivable that a permanent and intimate mingling of the two characteristics might occur, so that no process of segregation need subsequently ensue. Mendel found in the case of certain plants that when white-flowering and red-flowering varieties are crossed, the plants of the first crossed generation produce flowers that are not red, but pink, that is to say are the outcome of an equal mingling of red and white. Such a result, however, is not permanent, for in the second generation a partial separation of characters occurs: 25 per cent. of the plants of this generation bear red flowers, 25 per cent. white, and 50 per cent. pink; and when the red-flowering plants of this generation are now bred with one another, these same results are repeated in the succeeding generation. Thus a portion of the plants always remains mixed. In Fig. 7 we have a diagrammatic representation of these relationships, similar to that given in Fig. 6 of the inheritance of a dominant character. The same lettering is used in both figures, so that it is needless to give another detailed explanation.

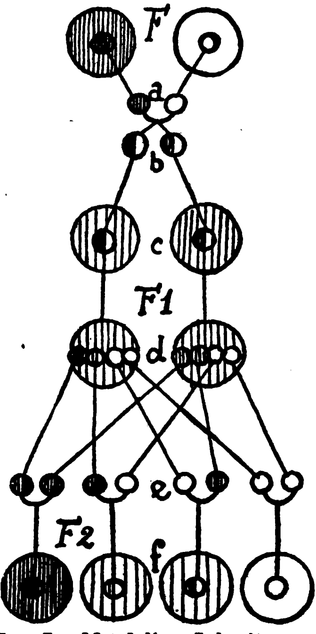


FIG. 7.—Mendelian Inheritance. Explanation in Text.

The chief difference between the two figures is that in Fig. 7 the intermediate or pink colouration is indicated by a striation with wider interspaces. Thus we show that the individuals at c and d exhibit a pink colouration, and in the bottom row of individuals, at F_2, the two intermediate specimens are also pink. The behaviour of the germinal cells is precisely similar to that which occurs in Fig. 6. In the case of diseases, we cannot recognise any such mingling of characters as may occur where the colours of flowers are concerned. Indeed in the former case we could not readily anticipate that any such intimate admixture could occur. It would be difficult for a healthy rudiment to enter into close combination with a diseased rudiment. More easily than in the case of the colour-rudiments the diseased rudiment and the healthy rudiment would remain distinct though side by side, and would thus be more liable to separate once more.

The question now arises whether these theoretical considerations do really apply to the case; whether, that is to say, a separation of the normal from the morbid rudiment actually occurs; and, in especial, whether the phenomena of disease-inheritance display similar percentage relationships with those that obtain in Mendelian experiments.

Numerous investigations have recently been made to throw light upon this problem. It must first be pointed out that in the inheritance of disease a segregation of characters obviously occurs. We have repeatedly drawn attention to the fact that it is quite exceptional for all the children of diseased parents to be themselves also diseased. As a rule, a part only of the offspring is affected. It is, however, extremely difficult to ascertain whether the percentage relationships between the healthy individuals and the diseased correspond with Mendelian rules. On this matter also we have numerous reports.

First of all it is evident that the numerical relationships must depend upon the respective constitutions of the par-

ents and upon the nature of the crossing—must depend, that is to say, upon whether the parents' bodies contained diseased germs only (as certain plants in the experiments contained red germs only), or whether the parents' bodies contained germs part of which were healthy and part diseased (as the plants of the first crossed generation of Mendel's experiments contained germs with red and white rudiments). In the latter case, the diseased parents are themselves the offspring of diseased ancestors, and of such a nature are most of the cases with which we have to do. But the next question we have to consider is whether these diseased individuals unite in procreation with healthy individuals, or with others who are similarly abnormal.

Let us first consider the case in which all the germinal cells in the body of a diseased individual are themselves also diseased. This occurs in those parents who are independently diseased, and also in the case of 25 per cent. of the second generation (and of following generations) which have resulted from the conjugation of two diseased germinal cells of the first generation. When such individuals procreate in conjunction with healthy individuals (or in conjunction with those similarly affected with disease) all the offspring must be diseased if the pathological state is a dominant character. On the whole such an occurrence is rare. Neither in the first generation, nor in genealogical trees relating to several generations, do we often find that all the offspring of such individuals are themselves diseased.

Secondly let us suppose that we have to do with diseased individuals of the first generation (or of subsequent generations) which are the offspring of a union between a diseased person and a healthy one, and in whom for this reason the germinal cells are partly diseased and partly normal. If such persons procreate in conjunction with healthy individuals, the result would be the production of offspring one half of whom are diseased. Results approximating to this are not infrequently observed in practice.

Thus, in the cases of hypotrichosis (deficiency of hair), to which reference has previously been made, there was one family in which there were three diseased children and four healthy, and another in which seven were diseased and seven healthy. Such a numerical relationship is often more plainly manifest when, instead of considering the separate families, we deal, as in the experiments upon plants, with all the children of all the families of each generation as a whole. In a genealogical tree of a family affected with a malformation of the hand, we obtain, for example, in four successive generations, the following ratios between healthy and diseased members, 4:4, 5:7, 7:9, and 17:16.

Thirdly and finally, when diseased individuals whose germinal cells are partly healthy and partly diseased unite in procreation with others similarly affected, whether these are or are not of near kin, according to the Mendelian rules the ratio of the diseased to the healthy members in the second generation ought to be 3:1. A clear manifestation of such a numerical relationship is seldom encountered, and objections may be raised against many genealogical trees that have been regarded as establishing the existence of such a relationship. It is true that the genealogical trees in question exhibit the required numerical ratios (three diseased children to one healthy), but the conditions affecting the parents have not always been of a kind that would lead us to expect such a relationship. When, for example, it is reported that of the two parents only one was diseased, the 3:1 ratio ought not to be manifest. If the germs in the body of the diseased parent were all diseased, all the children ought to be diseased; while if the germs in the body of the diseased parent were half healthy and half diseased, half the children ought to be diseased. We find, then, that such genealogical trees afford but insecure evidence. Recently, indeed, F. Pick has reported a genealogical tree observed by Pribram relating to diabetes, and this appears to comply with our requirements. Two

diseased parents had four children, three of whom were diseased while one was healthy. We know nothing, it is true, about the condition of the germinal cells of these parents. In the following generation, however, the figures failed to correspond to the Mendelian canon. One of the diseased children, married to a healthy individual, had three children, two of whom were diseased while one was healthy. I mention these observations simply for the reason that I am about to explain their lack of precision.

Hitherto we have assumed that the diseases are *dominant*, bearing towards health the relationship that the red colouration in Mendel's experiment bore towards the white, the latter character being termed *recessive*. Every character that yields before another is recessive, and diseases may do this. In such cases they may appear in numerical relationships similar to those exhibited by the white-flowering plants in the Mendelian experiments. Farabee (quoted by Haecker, *Allgemeine Vererbungslehre,* 1911) observed this in a case of albinism, in which among the offspring four individuals were affected with albinism and eleven free from this condition. Here also, however, the figures do not precisely correspond to the requirements. Pick, again, records two opposite observations. One concerns alcaptonuria, a disease in which the urine exhibits an abnormally dark colour and leaves dark stains on the underlinen. Of twelve children, three were affected with this condition, but no definite information is given as to the health of the parents. The other case relates to a skin disease, the so-called xeroderma pigmentosum. Here of eleven children three were affected. The parents, however, were healthy, so that it is impossible to ascertain what would have been the numerical ratio of the affected children to the immune. We see how great are the uncertainties attending the demonstration of Mendelian inheritance in human beings.

Why is it that, in the inheritance of human diseases, we do not more frequently find a precise correspondence with Mendel's figures, although segregation of characters cer-

tainly occurs—for only a portion of the offspring is affected with hereditary disease—while we are forced to assume on theoretical grounds that the process of disease-inheritance must take the same course as that which we observe in the characters of plants and in the qualities of normal animals? The explanation is simple. In experiments upon plants nearly all the ova and a notable proportion of the pollen grains engage in acts of mutual fertilisation, and out of these large quantities good average results can be obtained. In the case of human procreation the conditions are very different. The number of the offspring is often so inconsiderable as to render the deduction of general rules out of the question. Even when a human pair is prolific, when, for example, the offspring number from six to ten, this number is still very small compared with the number of the ova that actually ripen in the human female during the period of reproductive activity, for this number is about 360. Really valid conclusions could be obtained only if we could deal with this total number, and to gain conclusions even approximately valid we should need to deal with a far larger number of instances than ten. We therefore could not expect to find Mendelian rules of inheritance applicable on the average to the inheritance of human diseases. It is obviously possible that in isolated instances the figures may correspond approximately or even precisely to the Mendelian type, as is shown by the cases quoted above. It is impossible to expect, however, that we shall ever be in a position to anticipate the exact ratio between healthy and diseased children.

For completeness of exposition we may add that the inheritance of normal human qualities likewise fails to correspond to Mendelian rules. Undoubtedly a segregation of characters is often plainly manifest. A permanent admixture (analogous to that whereby in the experiments on plants the admixture of white and red produced pink) is exceptional. Such an admixture, indeed, is the ordinary

outcome of intermarriage between negroes and whites, for in the offspring of such unions we observe an intermediate tint of skin, which persists, when mulattoes interbreed, in subsequent generations. Only one exception to this rule has hitherto been observed. Certain castaways on a South Sea island intermarried with the natives, and the offspring of the first generation were of an intermediate colour. In the subsequent generations, however, segregation occurred, leading to the production of distinctively white and dis-

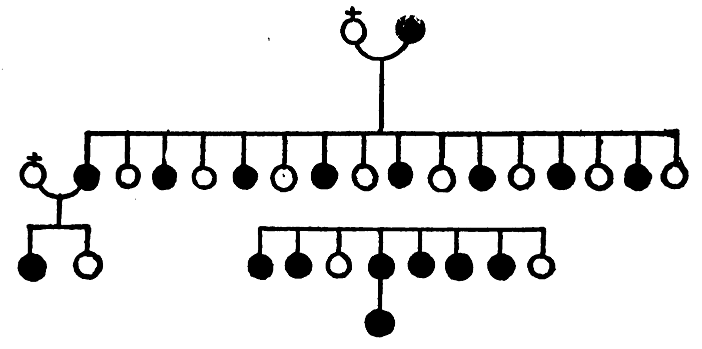


FIG. 8.—Genealogical Tree showing the inheritance of curly hair (after Von Gruber and Rüdin). The black circles denote individuals with curly hair. The figure serves to demonstrate direct inheritance and segregation.

tinctively coloured individuals. Apart from this instance, we have no information as to the segregation of racial characters. In the case of other normal qualities, however, such as the colour of the eyes and the hair, segregation is often observed. In one family, in which some of the members had straight hair and others curly hair, these two characters were very sharply separated. In one generation there were eight individuals with curly hair and eight with straight, but in the following generation the ratio was irregular, for there were six individuals with curly hair and two with straight (Gruber and Rüdin, *Fortpflanzung, Vererbung, Rassenhygiene,* 1911). We see that

here the inheritance did not take place in accordance with definite rules. In another instance, in which, as a family trait, there was a white lock in the midst of dark hair, some of the children exhibited this peculiarity and others did not, but here also the numerical ratios were irregular.

It appears, then, that in human beings the rules of Mendelian inheritance are as little applicable to normal characters as they are to diseased states, but in view of what was said above this cannot surprise us. Although on theoretical grounds we should expect Mendelian inheritance to occur in human beings, it is impossible, seeing how small a proportion of the human germs attain to fertilisation and undergo subsequent development, that we should find, in the facts of human inheritance, an approximate correspondence with Mendelian rules.

The fact remains that segregation is proved to occur in human beings in the case of many characters, both normal and morbid. This is a matter of practical as well as of theoretical importance, as will be shown in the sequel.

6. *Genesis of "Hereditary" Diseases*

The genesis of hereditary diseases is not a problem of theoretical interest merely; it is also one of great practical importance. Upon its solution depends the answer to the further questions, whether and how we can guard against the appearance of further abnormal states in addition to those that already exist, and whether in this way we can acquire a controlling influence over the process of human evolution.

In our previous expositions we have again and again contrasted the parental bodies and the germinal cells, and we introduce this contrast once more in the question we have now to ask, which runs as follows. Where do the changes originate which underlie the diseases that appear in hereditary forms; do they originate in the bodies of the progenitors or in their germinal cells? To one who first

approaches this problem it appears self-evident that the pathological change must originate in the ancestral body. If something must be transmitted by inheritance from parent to offspring, it must first, it would seem, exist in the parent. This reasoning, however unanswerable it may seem at first sight, does not apply to the genesis of diseases, for the following reasons. If an abnormal state is to appear in the offspring, the rudiment of the abnormality must already exist in the germ out of which the new individual is to proceed. How did this abnormality find its way into the germ? Did it originate in the parental organism, to be transferred thence to the germinal cells within the parental body? This cannot have been the course of events, for in our discussion of the inheritance of acquired characters (pp. 106 *et seq.*) we saw that these are not transmitted to the germinal cells. Even if some persons fail to recognise that this is the case as regards normal qualities, no one doubts that the reasoning applies to morbid states. It is impossible for the disease-producing changes in the organs to be transferred as such in an equivalent sense to the germs. The reasons for this impossibility have already been studied, but it is necessary, in the present connexion, to return to the matter.

How does the pathological change whose recurrence we observe in the offspring originate in the body of the progenitor? It originates in this way, that some noxious influence affects the tissues and injures them, the disease being dependent upon this injury. To explain the recurrence of the disease in the offspring we should be forced to assume that this change has exerted an influence upon the germ, for only in this way could a corresponding pathological transformation be effected in the germ. But if this happens, the change that has taken place in the parental body must effect in the germ the same transformation which the external noxious influence has affected in the parental body. Let us assume, for example, that the noxious influence has induced a malformation in one of the parental

organs, this malformation must in its turn so affect the germ as to induce in the corresponding organic rudiment in the germ the potentiality of the like malformation. But this is impossible, for to assume that it is possible involves the belief that the like abnormality may be induced by two entirely different causes, in the parental body by the noxious influence from without, and in the germ by the influences that proceed from the altered parts. To give another example, on this reasoning we should be forced to believe that a valvular defect of the heart caused by micro-organisms must be potentially produced in the germ by the disturbances of circulation in the parent that are the outcome of the valvular defect. This course of events is obviously inconceivable.

It follows that the primary genesis of a hereditary disease cannot take place in the parental body, but only in the germ. Once this latter has been altered, the transmission of the change to subsequent generations will obviously occur in accordance with the principles explained in an earlier section (p. 102).

How does the germ undergo alteration? Is not the process related in some way to the existence of disease in the parental body? This is undoubtedly the case. Almost without exception, disturbances in the structure of the germ are due to changes in the parental body. It is doubtless conceivable that a blow or a squeeze might so affect the reproductive gland as to injure the germinal cells it contains without any suffering on the part of the rest of the parental organism. But, to say the least of it, such an occurrence must be rare.

Is there not, it may be asked, a contradiction involved, if we say, on the one hand, that acquired diseases are not transmitted to the germs, and, on the other, that ova and spermatozoa can become diseased only through the intermediation of the parental body? The contradiction is apparent merely. The change in the germs that arises through the intermediation of the parental body does not

arise because an abnormal condition previously affecting the parent now *per se* influences the germ, but in another way. First of all, it may be that the pathological changes in the parental organism injure the germinal cells in one way or another, but they never do so in such a way as to evoke in the germ the identical condition that exists in the parent. Secondly, the noxious influence that affects the parental organism may not limit its action to that organism, but may also exert an injurious effect upon the germ. In either case, the morbid disposition is independently produced in the germ.

Some examples will make this clear. To consider the first mode of action, let us suppose that in the parent there occurs an inflammation of the kidneys, induced by micro-organisms or by poisons, and that the outcome of the disease is that substances which should be eliminated by the kidneys are now retained within the body and act as poisons. The germ may also suffer from the action of these poisons, but it does not necessarily follow that what is injured in the germ will be the rudiment of the kidneys so that in the child that subsequently develops there will also be changes in these organs. It is more probable that if the retained substances affect the germ at all, the rudiments injured will be those of the same parts that are injuriously affected by these substances in the parent, that is to say the heart and the brain. Thus the child of the parent suffering from kidney disease might suffer from some impairment of the mental functions.

It is doubtless conceivable that the poisons in question might attack the kidney-rudiment of the germ. First, however, we may be certain that the result would not be to induce a kidney disease of the same kind as that which has been caused in the parent in another way, by quite different poisons; and secondly we should have to do here, not with the transference of an organic change to the germ, but merely with the independent production of a disturbance in the kidney rudiment of the germ.

Let us take another example. When in the parental body the thyroid undergoes changes leading to the production of Graves' disease, the chief incidence of this affection is upon the nervous system, for there ensues a marked general nervousness in conjunction with other disorders. If we accept the view that the symptoms of the disease arise in consequence of the production of abnormal substances by the thyroid, substances which act as poisons in the parental body, it is obvious that the germ may also be injuriously affected by these poisons. On what, however, would the poisons take effect. Naturally upon the nervous system, or rather upon the rudiment of that system, and it would be theoretically conceivable (although we have no evidence that anything of the kind occurs) that the individual subsequently developed out of the germ thus injured might display like nervous disturbances. On the other hand, it is not possible that the rudiment of the thyroid in the germinal cell should be affected in the same way as the thyroid is affected in the parent, that the thyroid-rudiment should undergo such a change as to induce subsequently the appearance of Graves' disease in the offspring. In the parent the changes in the thyroid are caused in an altogether different way, and in that way only could a corresponding change be induced in the thyroid-rudiment of the germ.

As regards the second kind of causation, that in which the germs are directly injured by noxious influences that affect the parental body, we may illustrate the mode of operation by reference to the diseases caused by micro-organisms. When such organisms give rise to an inflammation of the valves of the heart, this inflammation is not transmitted as such to the germ. It is possible that the toxins produced by the micro-organisms may injure the heart-rudiment of the germ. It may then result that the child will have an abnormal heart, perhaps one of the familiar congenital malformations of that organ, but it will certainly not have an inflammation of the cardiac valves,

for such inflammation is not induced by toxins but by the direct action of micro-organisms. If it be suggested that the organisms themselves might invade the germ, it suffices to answer that they can exercise an inflammatory influence upon the valves only when these actually exist. Since, however, in the germ there are no heart-valves, but only the rudiments of these, it is impossible for the micro-organisms to act in the suggested way. It is, in fact, highly improbable that these particular organisms invade the germs at all, and failing such direct invasion they can act on the germs only through their toxins. If they do this, it does not follow that the heart-rudiment will be the one affected, for their injurious influence may be exerted upon some other rudiment. Similar considerations apply to all the other infectious diseases. These involve dangers, not only to the parental organism, but also to the germinal cells (and in many cases it is the brain-rudiment which is especially exposed to danger). It does not follow that the injurious influence will be exercised upon the same organ both in parent and in germ. Even if this should be the case, what has occurred is not a transference of the change from the parental organ to the rudiment of that organ in the germ, but merely an independent production of the change in the germ.

The non-bacterial poisonings furnish us with an additional example, and the most salient of these is alcoholic poisoning. Alcohol permeates the parental body, and besides affecting one or other organ in this body, such as the liver or the brain, it may injure the rudiments of these organs in the germ. In such a case the offspring will exhibit morbid phenomena similar to those manifested by the parents. Here like changes are independently induced in two different places, but there has been no transference; of the brain anomaly, for instance, from the parent to the germ.

These examples may suffice. They show clearly that the germinal cells may be injured in consequence of abnormal

conditions in the parental body, but that in such cases we never have to do with the transference to the germs of morbid conditions acquired by the parents. It has been shown, on the contrary, that morbid states in the germ arise always independently of those in the parent, and that the former states are sometimes induced by a similar process of causation as the latter, and sometimes in a different way.

The inheritable diseases that appear in the following generation therefore originate in the germ, not in the parent, although the abnormal state of the body of the parent is an intermediary factor in the production of the independently arising lesion of the germ.

Let us now pass from these theoretical considerations to examine what we actually know as to the genesis of hereditary diseases. These must be divided into two categories, requiring separate consideration.

In the first category we place numerous hereditary pathological states about whose genesis as diseases of the germ we know absolutely nothing. To this class belong haemophilia, colour-blindness, night-blindness, various malformations, many anomalies of the skin and of the eye, polyuria, alcaptonuria, tumours, obesity, gout, diabetes, and many changes of the nervous system.

What ideas can we form as to the genesis of these diseases?

The first possibility is that some pathological condition in the parent has exercised an injurious influence upon the germ. There may have been a kidney change, an anomaly of the thyroid, some infectious disease in consequence of which bacterial toxins have been at work, diabetes, etc., and the consequence may have been that one or other germinal rudiment has been injured, the one to be affected being dependent upon the nature of the injurious influence arising out of parental disease. It is conceivable that toxins might give rise to disturbances in the rudiment of the eye or in that of the skin, that haemophilia might be induced by

some influence affecting the vascular rudiment, that malformations might be the outcome of changes operating on the rudiments of individual organs or extremities, or that hereditary mental disorder might be caused by injury to the brain-rudiment. But we lack well-grounded observations in support of any such hypothesis, nor can we conceive how such observations are to be made. It is impossible for us directly to observe an injury to the germ. Only by way of an extraordinarily laborious statistical investigation could we attain to any result, namely by making a detailed examination of the family histories of those affected with certain anomalies, and drawing conclusions from the frequency of coincident phenomena. But such a method will always remain extremely uncertain.

A second conceivable possibility is that the germs derived from the respective parents are unsuitable to one another, and that this unsuitability leads to disturbances in the act of fertilisation. This is a possibility which has often been mooted, but the attainment of secure principles is here hardly possible. It is merely a hypothetical explanation, proposed in the lack of something better.

In the third place it is necessary to point out that the origination of diseases *de novo* may well be apparent merely. There is no doubt that germinal anomalies may remain latent for generations, and only manifest themselves again when circumstances arise specially favourable to their appearance. If the former occurrence of these pathological states has been forgotten, they are supposed to have originated *de novo*. There can be no doubt that such oblivion plays a large part in the explanation. We are led to see this by the simple consideration that none of the morbid states to-day observed to be hereditary made their first appearance in the times in which we now live. It is practically certain that they have always existed. If, however, this is so, they may from time to time have become latent, and have subsequently reappeared. When we examine genealogical trees that cover a sufficient number of

generations, we can actually verify this fact. The diseases disappear from time to time, it may be for two or three generations. As a rule such a period of latency suffices to make people forget the earlier occurrence of the disease—at any rate until it reappears. And the period of latency may exceed two or three generations.

The objection may be made that such a view affords no aid in explaining the genesis of disease. This is perfectly true. The further back into the ancestry we traced the incidence of a disease, the less do we secure any useful lights as to its etiology. Ultimately we find that there is hardly any other conclusion open than to regard such diseases as anomalies permanently affecting the human race, making their appearance from time to time after longer or shorter intervals of latency. At first sight this view may seem astonishing, but we must bear in mind the possibility that many hereditary anomalies may find their ultimate explanation in the persistence in human beings of certain peculiarities derived from our pre-human ancestors, characteristics which are not now properly adapted to the human organisation, and are therefore in our own day no more than intrusive abnormalities. We think, in this connexion, of some of the anomalies of the skin, of certain malformations, of colour-blindness. Such considerations as these, which are of necessity purely speculative, must not be carried too far. We may, however, refer, in passing, to the well-known fact that Lombroso has endeavoured to explain criminal tendencies as a reversion to the savagery of the ancestors of our race.

Some brief remarks upon atavism will here be appropriate. If the objection be made that we are hardly justified in assuming a reversion to characters belonging to so remote an epoch, the soundness of this contention might be admitted if what was supposed to occur were the reappearance of a character which had been in complete abeyance throughout the intervening period. But such an assumption is unnecessary. We may suppose that the ab-

normality may have recurred at intervals since prehistoric days. In that case we should really have to do, not with true atavism, but with discontinuous inheritance, a condition which offers no difficulties to our understanding, and one whose existence we are justified in postulating as the real explanation of the phenomenon known as atavism —the recurrence of ancestral characters, not merely in our own time, but at intervals throughout the history of our race. These remarks naturally apply, not only to morbid characters, but to all those characters in explanation of which the idea of atavism has been invoked.

There is an additional consideration that may be adduced in support of the derivation of hereditary diseases from remote generations of our ancestry. It is one brought to light by the application of Mendelian principles to the study of morbid inheritance.

If in any family one of the diseases whose genesis remains unexplained appears (apparently) *de novo,* we never observe that all the offspring are affected. Some invariably remain exempt. To express the matter otherwise, this signifies that the germinal cells from which the children proceed had not all undergone alteration. This partial exemption would, however, be inexplicable if the germinal cells had been affected by injurious influences operating within the parental body. For in such a case we are compelled to believe that all would suffer alike. It is, indeed, conceivable, as previously explained (p. 137), that the injurious influence did not begin to operate until after the birth of some of the children, and that for this reason the later children only were affected. But such a distribution of disease in a family is not commonly observed. What we usually see is an irregular distribution among the offspring. It follows that from the first only a portion of the germs can have been diseased, and in that case it is impossible that the pathological condition can have come into existence within the parental organism. It must derive from earlier generations. At that time, a germ diseased for some rea-

son united with a healthy one, and subsequently the Mendelian process of segregation ensued, in consequence of which, in subsequent generations, there always existed in the individual body both healthy and diseased germs (as in the Mendelian experiments on plants there existed red and white ova) in approximately equal numbers. In that case it is obvious that only a portion of the offspring would become ill, and in accordance with Mendel's rules about one half of them would be diseased. Since this is what we actually observe, we must conclude that the disease which apparently originates *de novo* really derives from an earlier stage in ancestral history than that occupied by the apparently healthy parents.

Yet another attempt has been made to explain the genesis of hereditary morbid conditions. It has been suggested that these anomalies may appear as mutations (sports) in the human evolutionary process, that is to say, as discontinuous variations, of the same character as those shown by de Vries to occur in plants, and since then largely utilised in the theory of evolution. Mutations, however, are perfectly normal phenomena, which play their part in the general process of evolution of the entire organic world, and which manifest themselves within this process without the operation of any special causative factors. It is impossible to regard abnormal conditions as upon the same footing with these. It is inconceivable that the typical development of organisms could ever of itself give rise to morbid variations. To suppose this would be in complete contradiction with the concept of mutation. It is therefore impossible to accept the suggested explanation, and to admit that the occurrence of haemophilia or of colour-blindness can be explained as a process of mutation. If, further, it be suggested that we may assume some new influence to have induced the changes, this idea also is out of harmony with the concept of mutation. All that we should have in such a case would be the production of dis-

ease by noxious influences. Hence it is impossible to invoke mutation to explain the genesis of morbid states.

The second category of hereditary diseases comprises those as to whose genesis we believe ourselves to possess more or less valid explanations. The first place in this group is occupied by nervous and mental disorders (epilepsy, idiocy, imbecility, and the various diseases of the mind). According to the views now dominant, these diseases arise through a poisoning of the germinal cells, in many cases effected by the toxic products of various micro-organisms. It is true that in this connexion indisputable facts are lacking, but those who support the theory lay especial stress upon the case of syphilis. With good reason we ascribe to the toxins manufactured by the organisms that are the exciting causes of this disease an exceptionally powerful influence upon the nervous system. We know that locomotor ataxia and general paralysis of the insane must be regarded as sequels of syphilitic infection. It is, therefore, readily comprehensible, and indeed probable, that the same toxins may affect the rudiments of the nervous system in the germinal cells.

Among the non-bacterial toxins alcohol is especially blamed for the appearance of numerous mental disorders which are supposed to be caused by the influence of this poison upon the germinal cells. No doubt this accusation is justified. We see, on the one hand, that alcohol exerts its influence above all on the central nervous system, and that alcoholics frequently suffer from mental disorder. On the other hand we know that the whole body of the drinker is permeated with the poison, so that the germinal cells as well as others may be injured thereby. Thus it is possible that in this action on the germinal cells rudiments of the central nervous system may be injured in such a way that the individuals subsequently developed exhibit mental anomalies.

In view of the great importance ascribed to alcohol we shall discuss its influence in fuller detail.

As regards the demonstrable anatomical influence of alcohol upon the reproductive glands, recent researches seem to show that this influence is exerted upon the spermatozoa-producing cells of the testicle. In a large percentage of drinkers it has been possible to demonstrate the occurrence of destruction of the seminiferous tubules and their replacement by connective tissue. But before the germinal cells are completely destroyed they will naturally be injured in some way. If at this stage in the process, and before the alteration is too extensive, spermatozoa are produced and take part in fertilisation, the injury they have suffered may have harmful results in the newly-formed individuals. Forel, who has devoted himself to a thorough study of the consequences of alcoholic intoxication, gives to this process of poisoning of the germ the name of *blastophthoria*.

Among the consequences ascribed to the effect of alcohol upon the germinal cells is one suggested by von Bunge, who believes the incapacity of the daughters of drunkards to suckle their children to be due to this cause. He regarded as especially significant, cases in which mothers, the wives of drinkers, could suckle their children, while their daughters were unable to do so. This incapacity of the daughters of alcoholics to suckle their children is said to be transmitted to subsequent generations. Several additional investigators have confirmed von Bunge's statistical statements; but others, and especially Agnes Bluhm regard his conclusions as unsound. Above all, it has to be admitted that the reports as to the amount of alcohol consumed by the father are not always sufficiently precise, and also that the failure of the daughter to suckle her child may sometimes be the outcome, not of inability, but of unwillingness. In the case of 39 of the daughters of alcoholics, A. Bluhm found 25 fully competent to suckle (64 per cent.), and among the remaining 14 not all were completely incompetent. At present we still lack further light

on these contradictory results, and the question must therefore remain open.

A. Bluhm has approached the problem more directly by experiments on animals. She administered poisonous doses of alcohol to male rats during many months, but was unable to observe any diminution in the capacity for suckling on the part of the female offspring of these animals.

The possibility of other consequences of alcoholic poisoning has been made the subject of experiment. Ethylic alcohol was administered to fowls for a number of years. It resulted that in the eggs of these birds the chickens developed imperfectly, suggesting that the germs had been injured by the alcohol. It might be objected that the health of the parent birds had been depressed by the alcoholic poisoning, that for this reason they produced defective eggs, so that the imperfect development was not the direct effect of the alcohol. Still, the experiments were not without value, for even if there did not occur a genuine intoxication of the germinal cells, nevertheless the germs had been indirectly injured, and for this reason individuals may have been born with transmissible defects. Thus the alcoholic intoxication had a causative influence.

In another series of experiments, dogs were given beer. The offspring of these animals drank beer in preference to water. It was inferred from this that the germs had been injured by alcohol in such a way as to give rise to the abnormal habit in the offspring. To this the objection has been raised that the suckling mother-animals were still being given beer, and that the bitter substances in this beverage are excreted in the milk. The puppies might well have become so habituated to this bitter flavor that when, after suckling had been discontinued, they wanted to quench their thirst, the bitter-tasting beer would be more agreeable to them than water. It is therefore not necessary to assume that the craving for alcohol was itself transmitted by inheritance.

Certain other experiments are on record in which alco-

hol was administered to dogs for years, and in which the offspring of these animals showed an exceptionally high and early mortality, or were epileptic, atrophied, or malformed. We can hardly avoid the conclusion that these anomalies were dependent upon intoxication of the germ.

Experiments upon guinea pigs made by Laitinen showed that the offspring of animals poisoned with alcohol developed imperfectly as compared with the animals in control experiments, and that the former were less resistant to infectious diseases than the latter.

A like result has been established in other experiments. Kern intoxicated animals with daily doses of alcohol and then infected them with tubercle bacilli. The alcoholised animals died more quickly and in a larger percentage than animals in control experiments. Laitinen obtained similar results. He infected rabbits and guinea pigs with tubercle bacilli, and to some of the animals gave alcohol in addition to their food, but to others water only. The alcoholised animals died in larger percentage. He found, in addition, that the offspring of the alcoholised animals died in a much greater proportion. The reason for the difference is probably to be found in the fact that alcohol inhibited the formation of antitoxins in the body, and that this disturbance was transmitted to the offspring through the intermediation of the poisoned germinal cells.

We have no reason to suppose that what has been established by such experiments upon animals is inapplicable to human beings. Moreover, the accuracy of these theoretical deductions is confirmed by experience. There is abundant evidence to show that the children of drunkards exhibit an excessively high and early mortality. According to statistical data collected by Sichel, among 523 such children, only 203 were known to be healthy, as to 118 precise information was lacking, 200 died before or shortly after birth. Of these last, 51 were born prematurely, 20 stillborn, 75 died almost immediately after birth, 21 succumbed to convulsions, and 32 to infectious diseases—the death of these

last illustrating the before-mentioned lack of resisting power to infectious diseases exhibited by the offspring of drunkards.

If we are justified in concluding from such observations that alcoholism in the parent diminishes vital capacity in the children, we must also recognise that in those children of alcoholics who survive, the poison may induce all kinds of injuries in various organs, and above all in the brain.

Alienists are in general agreed that alcoholism plays a great part in the causation of mental disorders, and the only difference of opinion is as to the extent of its influence.

In the family histories of those admitted to lunatic asylums the excessive use of alcohol is a common feature, and in many statistical statements the percentage of lunatics who have had alcoholics among their progenitors is so high that we cannot doubt the existence of a causal connexion.

The offspring of drinkers are in many cases drinkers themselves, and they may suffer, either independently or in association, from a tendency to alcoholism, from various forms of mental disorder, and especially from epilepsy and from dementia praecox.

Alcohol plays a very great part in the causation of epilepsy. In one series of cases, in which particulars were collected relating to 83 epileptic girls, in 60 of them it could be shown that alcoholism existed in the parents.

In the case of school children exhibiting deficient intelligence, alcoholism in the parents can be shown to exist in a high percentage of cases. In a recent report on this subject by Schlesinger, drunkenness in the parents was proved to exist in 30 per cent. of such children. This number, however, is certainly below the mark. When the children with deficient intelligence from the families of alcoholics were compared with those of the children with deficient intelligence from sober families, the former contrasted very unfavourably in development with the latter.

Defects of intelligence and of character were far more conspicuous in those with an alcoholic family history.

In contrast with these and similar experiences, the reports of Pearson and Elderton have attracted great attention. They give the results, among others, of investigations relating to 1,450 school children from among the Scottish poor, and they show that the general health of the children of alcoholics is better than that of the children of sober parents, and that the mental defects of the offspring are not related to the alcoholism of the progenitors. From many sides objections have been raised to these investigators' conclusions. It is impossible here to discuss the objections in detail, but they have shown that Pearson's views on this matter cannot be accepted without reserve.

With regard to this question of the importance of alcohol, reference is also made to the fact that Jews suffer less from epilepsy than members of other races. As has previously been shown, it is very generally held that a potent cause of epilepsy is alcoholic intoxication of the germ, and the comparative exemption of Jews from epilepsy is supposed to depend upon the fact that the members of this race are less inclined than Gentiles to the abuse of alcohol.

It is also maintained that children actually procreated when the parents are in a state of alcoholic intoxication are especially apt to be mentally abnormal. It is, however, extremely difficult to obtain adequate evidence bearing on this point, and the existing statistical investigations do not suffice to justify the foregoing statement.

We may conclude by referring to one good example furnished in support of this allegation, in which a woman married to a healthy man procreated healthy children. After his death, having married a drunkard, she had offspring some of whom were epileptic.

Against this and similar observations the objection may be made that the mental disorder was not the direct outcome of the abuse of alcohol, but that the abuse of alcohol

was merely a symptom of a pre-existent disturbance in the mental faculties and that it was this disturbance which was transmitted by inheritance. Unquestionably this is possible. The view receives considerable support seeing that the tendency to drunkenness is itself dependent on the individual's constitution. A great many persons may at particular periods of life (for example, during their career as students) consume considerable quantities of alcohol for a long time, without thereby being led to become drunkards. There is needed a certain ethical inferiority (which may, of course, be derived from drunkenness in the parents) if the misuse of alcohol is to become truly habitual. If, therefore, any one becomes a drunkard, this may very often depend upon his primary constitutional abnormality, and hence his children may also be abnormal. The misuse of alcohol is then merely a sign of the pre-existing abnormality.

The examination of certain genealogical trees shows that this view is justified. In the ancestry of families who now exhibit alcoholic tendencies in conjunction with mental disorder we sometimes find that there existed mental anomalies before a family tendency to the misuse of alcohol had become apparent. We may also find that in such a family, side by side with abnormal individuals who are drunkards, there occur other abnormal individuals (especially females) who are not drunkards. It is here evident that mental disturbances exist as family peculiarities, and this leads us to recognise that the abuse of alcohol by the drunken members of the family may have been dependent upon the inherited mental disorder.

The following consideration must also be given due weight. If among a hundred children with deficient mental capacity we find that fifty had alcoholic progenitors, we may presume that the remaining fifty had sober parents. Such children can therefore be procreated in the absence of any alcoholic influence. How is it possible for us to determine whether the parents who drank to excess might

not have produced children with deficient intelligence even if they had not themselves been addicted to the abuse of alcohol? How can we prove that the drunkenness was more than a casual accompaniment? It is obvious that definite proof is hardly obtainable. Reference must again be made to the observation that the children of alcoholics exhibit greater deficiencies in physique and character than the children of sober parents, and that there is good reason for referring this inferiority to the effects of alcohol. But if this must be admitted, it must also be recognised as possible that the deficient mental capacity in the children of alcoholics owes the same causation.

As regards other mental disorders, the same difficulties arise as in the case of children exhibiting deficient intelligence. In individual cases it is often difficult or even impossible to determine whether the alcoholism or the mental disease is the primary or the secondary defect.

We may sum up this discussion by saying that while the question as to the significance of alcoholism in causing germinal intoxication, and thus inducing hereditary disease, has not yet been answered in all its details, in view of the general experience of the poisonous influence of alcohol (extending also to the reproductive glands), in view of the results of experiments on animals, and in view of statistical records, no one will venture altogether to deny the injurious influence of this poison upon the germinal cells. In any case we must regard the misuse of alcohol as a noxious influence competent to lead to the production of hereditary anomalies. The future must, however, decide whether the opponents of alcohol are not inclined to overstate their case. We have to remember that among many nations the use of alcohol is so general that it is quite exceptional for any male adult to abstain from this beverage, and that its use has been habitual for many centuries. If the presumed germinal intoxication were really as widespread and as severe as is sometimes asserted, we should expect the consequences of such an influence to be far graver than

those we are actually able to observe. More comprehensive investigations are requisite before we can determine with certainty how much mischief can be ascribed to the use and abuse of alcohol.

To sum up, in conclusion, the results of our inquiry as to the genesis of hereditary morbid states, we are forced to the general conclusion that we still lack adequate information on this matter. We may, indeed, assume that noxious influences of all kinds, acting on the germs through the intermediation of the parents, lead to alterations in the germinal cells, as a result of which there appear in the children pathological conditions susceptible of further transmission by inheritance. When, however, we consider the case of individual diseases, we find that there is hardly one as to which, in this respect, we possess any tangible knowledge. Even in the field where our knowledge is most extensive, namely as regards the effect of alcoholism in originating hereditary mental disorders, far more comprehensive investigation is essential.

7. *Increase in "Hereditary" Diseases*

If hereditary diseases continue always in the future to be transmitted as they have been transmitted in the past, the number of sick persons must go on increasing concomitantly with the increase in population. The relative proportion of sick persons to the population might, however, remain unchanged, provided that no new diseases came into existence. Is this likely to be the course of events, or is it not possible that there may be a gradual falling-off in inheritance, leading to a diminution in the amount of disease? How could such a diminution arise?

First of all it is possible that the families in which hereditary diseases prevail may die out, and this for several reasons.

It is by no means rare for tainted families to display an exceptionally high child mortality, a fact which must

be explained upon the ground that the conspicuous hereditary morbid change is not the only one, but that the bodies of those thus affected are less vitally efficient, that they have suffered some general injury in consequence of the pathological condition. For example, we see something of this kind in hemophilia, although in families affected with this disease the high child mortality is partially compensated by an unusually high birthrate (see p. 130).

A similar excessive child mortality existed in the family characterised by hypotrichosis (p. 146). In one branch of this family in which there were fourteen children one only attained to reproduction. Moreover, at the time when E. Fischer made his investigation, there were still alive belonging to this family no more than two individuals, both in poor health, and both over forty years of age, and therefore likely to remain childless. In that event the morbid condition characteristic of this family would have completely died out.

A second possibility is that the diseased individuals will not marry, being shunned on account of their condition. Those with marked malformations will seldom find a mate, and the same is true of those suffering from mental disorder, etc. This happened in the family whose members were affected with hypotrichosis, for many of them remained unmarried.

We have thirdly to take into consideration that many of those affected with hereditary disease are incompetent for reproduction. This applies more or less completely to severe cases of alcoholism, mental disorder, diabetes, etc.

For the reasons named, tainted families may die out in the course of a few generations.

There is, however, a further possibility. The morbid state may be suppressed in consequence of marriage with a thoroughly healthy and vigorous individual from an untainted stock. It has again and again been recorded that when a member of some family affected with hereditary taint has married a healthy person, the morbid

heredity has come to an end in this branch, the offspring remaining healthy. Here the healthy constitution must have been the more powerful one, and must have overcome the hitherto dominant pathological tendency. We must interpret this in the sense that the morbid character no longer remained independent, no longer underwent segregation, but, permanently united with the healthy character, was no longer able to maintain a separate existence. It may ultimately have undergone atrophy and completely disappeared. This view is more acceptable than the other, that the morbid tendency had merely been weakened in contrast with the healthy one, that the former had simply become recessive. For even though recessive, it would have continued to manifest itself in a small percentage of the offspring. It is on the first assumption that we can best understand how through marriage with healthy persons, the morbid heredity may occasionally arrive at its term. Still, we have also to take into account the alternative hypothesis, that the pathological tendency may merely have become recessive, for in view of the small proportion of the human germinal cells that attain to fertilisation, it is possible for a recessive character to disappear from sight for several generations, and then to reappear. But this also would signify a notable diminution in the number of cases of disease.

When, however, we proceed to ask whether a general diminution of hereditary morbid conditions is likely to be brought about by the dying out of diseased families, and by intermarriage between the members of such families and those of healthy stock, we are unable, since new diseases are continually arising, to return a confident answer. The conditions just described have always obtained, and if they could exercise any effective influence in the desired direction, some improvement should already have resulted. Nothing of the kind has taken place, and we could only hope to attain good by such means if in the future we could deliberately intensify their employment

in order to secure a diminution in the extent of morbid inheritance. Of this we shall speak in the sequel.

First, however, we must once more draw attention to the fact that the disappearance of diseases through dying out and through intermarriage with healthy stocks may be apparent merely. As we have shown above, a hereditary morbid state may remain latent for one or many generations, and then recur as an atavistic manifestation. This possibility is established by numerous family histories, in which hereditary disease skips entire generations. It follows that hereditary diseases would not necessarily disappear for ever if we were to kill off all the individuals who were demonstrably affected. The offspring already procreated by these individuals, bearing the disease in a latent form, would transmit the abnormal taint to subsequent generations. At some subsequent period, when for unknown reasons the abnormality gains the upper hand over the healthy quality and becomes dominant, or when the recessive morbid character becomes spontaneously manifest (especially when the number of the offspring is large), the disease reappears. This is especially likely to occur if two individuals with identical disease-rudiments unite in procreation. It may ensue in the marriage of near kin, but also in the intermarriage of members of different families affected with the like hereditary taint.

The former possibility, that of in-and-in breeding, requires closer examination.

In perfectly healthy families (that is to say, in families that are really free from all hereditary taint, and not merely free in appearance at the time of examination), the marriage of near kin, if not too frequently repeated, is without ill effect. Observations on human beings and experiments on animals establish this clearly.

E. Fischer reports the history of a half caste tribe of Bosjesmen and Hottentots, among whom in-and-in breeding had continued for seven generations. The 2,500 individuals composing this tribe were thoroughly healthy.

There were no signs of degeneration. The birth-rate was comparatively high, and the child-mortality was no greater than among the neighbouring whites. Pöch similarly reports that in a Papuan tribe living in complete isolation, in-and-in breeding had not led to the appearance of any degenerative consequences.

Such experiences are in conflict with the views generally prevalent to-day, for the common idea is that in-and-in breeding must necessarily lead to injurious results. But this opinion has not always prevailed. Abraham married his half-sister without hesitation. In ancient Egypt, marriages between brothers and sisters were common, especially in the case of the Ptolemies, among whom are on record thirteen marriages between brother and sister, one between half-brother and half-sister, and two between uncle and niece. In Athens, again, marriages between brother and sister were not infrequent. The aversion from such unions to-day is sometimes supported by reference to the experience of breeders, who have in many cases seen injurious consequences from long-continued in-and-in breeding. Chapmann reports the following experiment. He reared 500 chickens in an incubator, and found that 50 of these grew no feathers; they remained callow and soon succumbed. He referred this to the fact that their progenitors had bred in-and-in for four years.

But there exist records of experiments which point to the opposite conclusion. Chapeaurouge records studies on thoroughbred horses, among whose progenitors in-and-in breeding had been frequent, and considers that this practice accounts for the remarkable qualities of the race-horse. This view was supported by the observation that celebrated stallions sometimes procreated inferior stock, but only when crossed with unrelated mares. From this we may infer that in-and-in breeding may lead to an intensification of the distinctive characters of particular stocks of animals, provided always the individuals thus in-bred are perfectly healthy in other respects.

In the case of reigning and noble families in-and-in breeding is also believed to have led to an intensification of their striking talents.

We may therefore go so far as to say that individual marriages of near kin belonging to a healthy stock are altogether free from objection. It is not the marriage between members of a normal family that can prove injurious to the offspring, but the marriage of near kin belonging to families in which hereditary morbid states prevail, or have prevailed in earlier generations.

It is true that we find genealogical trees and pedigrees in which marriages of near kin have occurred for several generations without disease resulting, but in later generations, when members of the family have intermarried, abnormal offspring have been procreated. It might seem in these cases as if the repeated intermarriages of blood-relatives had ultimately led to the production of disease, although the family was primarily healthy. A more probable assumption, however, is that the disease was already latent in the family, and underwent concentration through in-and-in breeding. In many cases, support to such a view is given by the observation that in other branches of the family the same disease appears in the absence of in-and-in breeding.

The effect of the marriage of near kin is conspicuous in the pedigree of Don Carlos, son of Philip II of Spain. His paternal grandfather and his maternal grandmother were brother and sister and their mother was Juana the Mad. His paternal grandmother and maternal grandfather were also brother and sister. Thus instead of eight great-grandparents he had four only. These four great-grandparents, in their turn, instead of being derived from eight different couples and sixteen individuals in the previous generation, were derived from three couples only and six individuals, so that the blood-relationship among the ancestry was extraordinarily close.

The pedigree of Louis II of Bavaria also shows numer-

ous marriages of near kin. In the fifth generation back are three male ancestors derived from tainted families, one of these being on the paternal and the other two on the maternal side. On the latter side of the pedigree, we also find in earlier generations that mental disease manifested itself several times, having been concentrated by the marriage of near kin. Moreover, numerous members of the family displayed more or less marked mental abnormality.

In certain pedigrees and genealogical trees, while it is true that there occur marriages of near kin leading to the procreation of offspring, in other branches, where the marriages have not been between blood-relations, there are so many diseased individuals, that on a review of the whole it is hardly possible to suppose that in-and-in breeding has exercised any notable influence. We cannot, indeed, doubt that the offspring, in such cases, of the marriage of near kin are tainted on both sides, and that they are therefore especially liable to inherit the taint. But a study of such genealogical trees shows us that even without in-and-in breeding the extensive hereditary transmission of disease may occur.

Marriage between individuals who are not related but who are hereditarily affected with the identical taint may naturally have the same effect as the marriage of two members of a tainted family in awakening a latent taint or in intensifying a morbid condition that is already manifest. This is true, in especial, of mental disorders, with or without the association of alcoholism. Intermarriage between members of families thus tainted leads to a concentration, to an intensification of the pathological state (see p. 135).

In the marriage of near kin, and in the marriage of persons affected with the same hereditary taint, we must recognise factors of the utmost importance for the progressive inheritance of abnormal qualities. Both these factors counteract the tendency to the dying out of hereditary diseases.

The efficacy of these factors is even greater than may appear at first sight.

As far as concerns the marriage of near kin in those families in which the morbid tendency is plainly manifest, we might hope for good results by discouraging such marriages. But the pathological disposition may be latent, and may have failed to display itself for several generations. If, then, as is commonly the case, no information is available concerning the illnesses of remote progenitors, the family may be supposed to be healthy, and it may be considered that there is no objection to the proposed marriage. Thus it is possible, and doubtless often happens, that after the marriage of near kin, especially when such marriages are repeated several times in the same family, a disease will unexpectedly come to light in a stock that was apparently intact.

Again, the kinship of human beings is far more intimate than is shown by pedigrees, for these never refer to more than a limited number of persons of earlier generations. For example, from the ancestors of persons now living, if we go back so far only as five generations, there must have sprung a great many descendants whose blood-relationship to the persons of this generation is completely ignored, but to whom a formerly prevalent morbid condition may naturally have been transmitted in a latent form. A marriage between two such individuals erroneously believed to be unrelated may lead to the reappearance of the disease in an active form. Very little reflection upon such conditions will show that it is extremely difficult, and may be altogether impossible, to ascertain whether persons supposed to be unrelated may not really harbour identical disease-rudiments. Accurate information on this point could be furnished only by complete pedigrees, extending back for numerous generations, of all persons now living, enabling us to demonstrate the mutual kinships of all of these. With the means now at our disposal the establishment of such comprehensive pedigrees is quite impossible. The iso-

lated families as to which data are available constitute to-day an infinitesimal number of exceptions. The exceptions are confined almost exclusively to the families of those whose members have been prominent in public life, and whose family records have for this reason been carefully kept.

While, then, it cannot be doubted that in-and-in breeding and the marriage of persons affected with the same taint favour the diffusion of hereditary diseases, we have now to show that the like significance has been ascribed to another factor, whose possible importance might be overlooked, namely hygiene. The primary aim of hygiene, and one that appears to be on all hands successfully attained, is to limit the prevalence of epidemic diseases. Among these may be mentioned the well-known diseases of childhood (measles, scarlatina, diphtheria, the intestinal disorders of infants, etc.), and also tuberculosis.

It has been said that the infectious diseases of childhood we have named carry off by preference weakly individuals, those who biologically are of deficient value, and consequently many of those who are hereditarily tainted. This is said to be a good thing. Thus, it is contended, our race is freed from worthless members, and only the vitally efficient survive. Hygiene, therefore, is a bad thing, for it interferes with this selective process, and promotes the survival of the weakly.

Less weight would have been attached to this objection if due consideration had been given to the fact that hygiene is a new acquisition, and that for this reason the selective process with which hygiene is now supposed to interfere must have been going on vigorously for many thousands of years. But, as every one can see, the results have been far from satisfactory, for if it were otherwise the continuance of the process would hardly now be necessary.

There are, however, other arguments by which such attacks upon hygiene may be answered. The statement is incorrect, or at any rate unproved, that epidemic diseases

affecting childhood lead to the death, for the most part, of the less vitally efficient individuals. There is no necessary relationship between the predisposition to the various infections and the constitution of the body in other respects. It is certain that the existence of mental disorders, malformations, hemophilia, colour-blindness, and other anomalies of the eyes and of the skin, does not justify us in assuming the concomitant existence of a deficient power of resistance to infectious disease. It may be suggested that such a deficient resisting-power would at least be found in children suffering from general bodily weakness; but in actual experience we do not find that such children are especially liable to suffer from the epidemic diseases.

It remains to consider the case of tuberculosis. It has been contended that children affected with this disease are preferentially carried off by the acute infections. This, however, is by no means the case. Those who have occasion to make frequent post-mortems on the bodies of children who have succumbed to infectious diseases fail to find in such cases any marked prevalence of tuberculosis. Very often the children appear to have been exceptionally vigorous.

It must therefore be admitted that the idea that epidemic diseases exercise a valuable selective influence on our race is erroneous. On the other hand, it has often been overlooked that such diseases may exercise a most unfavourable influence by leading to new injuries to the germinal cells. In these infections the entire organism is injured by the poisonous substances produced by the microorganisms which are the actual causes of disease. The toxins may injuriously affect the germinal cells. This possibility applies above all to tuberculosis, which involves very severe injury to the whole body.

Hygiene, however, which aims at and successfully effects a reduction in the prevalence of epidemic disease, necessarily counteracts such injurious influences affecting the germinal cells. Hence, for this reason also, we must desire

the greatest possible reduction in the prevalence of infectious diseases.

We also have to remember that the children who have suffered from some acute infection, even if they were perfectly healthy at the outset, and were therefore among those whose survival is to be regarded as especially desirable, are often permanently injured by the acute infection, sustaining damage to the kidneys, to the heart, to the blood-vessels, etc.

We must bear this in mind as we pass to the following considerations.

If it were true that high child-mortality were selective in its working, we should expect to find that in those regions in which such a high mortality usually prevailed the survivors would be exceptionally vigorous. One of several ways in which such exceptional vigour might be expected to manifest itself would be in the percentage of those found fit for military service, and this ought to be greater in these regions than in those where, in consequence of a lower child-mortality, the selective influence had not been in operation. It is not, however, possible to ascertain the existence of any such relationship. On the contrary, the records show that there is less fitness for military service precisely in those regions where child-mortality is high. Provided these statistical inquiries are based upon a sufficiently firm foundation, the inference would be that epidemic diseases had not exercised a favourable selective influence, and that the survivors had been injured by disease.

Thus it is on the whole quite without justification that hygiene is reproached with keeping the less fit alive and thus leading to an increase in hereditary diseases.

The case is somewhat different as regards another factor which has been similarly blamed, namely the care of the sick. There can be no doubt that such care keeps alive numerous individuals who are below par value from the outlook of heredity, far longer than they would have been

able to live in the absence of such care, and that, in consequence of this, there frequently arises the danger that such persons will reproduce their kind and procreate diseased children. Are we for this reason to leave such persons uncared for, in order that they may succumb the sooner? The author is not to be understood as making any such recommendation. In our efforts to promote the further evolution of humanity we are all dependent one upon the other, and this sense of solidarity extends also to the invalids of whom we are now speaking. To such sufferers, who are not responsible for their own condition, we must give our best attention, and we shall do so the more gladly the nearer they are to us. Doubtless we cannot fail to know that it would be better if they did not exist, but once they do exist we must assume responsibility for them. As, however, we keep them alive, it is necessary, since we must avoid by all means in our power an interference with the evolution of our race, that we should take care that patients suffering from hereditary disease shall not propagate their kind. To this matter we shall return in the ninth chapter. We have previously shown that we are forced to care for an extraordinarily large number of persons who will never again be functionally efficient, and this applies above all to severe cases of mental disorder. The necessity involves severe injury to our race, but the individuals in question are as a rule no longer likely to procreate.

We conclude that the diffusion of hereditary pathological states is promoted by in-and-in breeding, by the intermarriage of individuals affected with the same hereditary taint, and by the care we give to those suffering from hereditary disease unless we prevent such individuals from procreating.

We have also to take into consideration the genesis of new germinal diseases, especially in consequence of intoxication of the germ, by alcohol and other poisons artificially

introduced from without, and also by the toxins formed in the course of the infectious diseases.

There thus unquestionably exists a danger of the increase of hereditary diseases. Is the tendency in this direction stronger than are those tendencies which are favourable to a diminution in the prevalence of such diseases? This question will be considered in the next section.

8. *Is the Human Race Degenerating?*

If the hereditary diseases were continually increasing, the percentage of individuals invalided from the start, tainted in their innermost being, would also continually increase. Within a time not so extremely remote, their number would become so great that the continued effective existence of our race would become a difficult matter. Ultimately there would no longer be any healthy persons.

Such an increasing functional incapacity of the human race is assumed to be possible, and is denoted by the term *degeneration*. We have to ask whether the contingency need seriously be anticipated.

We must first of all make it clear that as far as degeneration is concerned it is only the hereditary diseases that can play a part. All other diseases than these, however destructive they may be, whether they induce speedy death or prolonged illness, have nothing to do with degeneration. They do not involve any increasing deterioration of the human race as a whole. They do not attack the foundations of the human constitution, or rather they operate in this direction only in so far as they exert an injurious influence upon the germinal cells and thus give rise to hereditary anomalies. If they do not do this they do not produce degeneration.

Moreover, not all hereditary morbid states contribute in equal degree to the presumed increasing constitutional deterioration. The slighter malformations, such as the hereditary absence of one of the fingers, involve no disad-

vantage to the race. Other anomalies, such as those of the skin and the hair, play an unimportant part. There are others, however, such as colour-blindness and short-sightedness, which are plainly degenerative in character. The most important of all, in this connexion, are disturbances of the nervous system, and especially all kinds of mental disorder (including criminality). The increase in these would depress mankind to a continually lower level, would involve the degeneration of the race.

What have we to say about such a constitutional deterioration of the human species?

In the last section we showed that many circumstances favour an increase in hereditary diseases, but that others counteract this. Since it is impossible to determine on purely theoretical grounds whether one set of influences or the other will predominate, we must seek light from positive experience. Can it, in fact, be demonstrated that hereditary diseases are on the increase? Those who have studied the subject return conflicting answers.

Rüdin, among others, contends that there is increasing degeneration. He is of opinion that suicide, which is certainly in great part dependent upon mental anomalies, is on the increase; psychopaths, neurasthenics, and certain types of criminals, are becoming commoner; that alcoholism with all the disturbances to which it gives rise, is on the increase; that diabetes and the incapacity of women to suckle their children are both becoming more generally diffused. He refers also to the decline in the birth-rate, in the production of which decline a degenerative factor co-operates; and, finally, to the increase of accidental neuroses and in unfitness for military service. The two phenomena last named must not, however, be unconditionally included under the head of degeneration. The accidental neuroses are acquired in consequence of individual injury, and are not therefore transmissible to the offspring. As regards unfitness for military service, this is due, not only to constitutional hereditary peculiarities, but also to all

kinds of acquired anomalies which have not been derived by inheritance from the parents.

Kraepelin also favours the view that degeneration is in progress. He refers especially to the increase in disease among the American negroes, who suffer more and more from alcoholism and softening of the brain.

Other students of the question hold the converse view. Wilmanns, for example, considers it questionable if racial degeneration is in progress. As to the alleged evidence afforded by the increase in mental diseases, he points out that all that has really occurred is an increased accumulation of mental patients in asylums. Those suffering from minor degrees of mental disorder who were formerly kept at home now receive institutional care because asylum conditions are greatly improved. A real increase in the number of mental patients could be proved only by a general census including all varieties of mental disorder, but no such census has hitherto been made. It cannot be denied that there is an increase in neuroses, but this does not signify degeneration, for illnesses of this character are not hereditary.

Weber also regards as untrustworthy the statistical evidence derived from the number of mental cases receiving institutional care. It seems to him that the severer forms of mental disorder have become less frequent, and he is therefore of opinion that the earlier pessimistic views as to the occurrence of degeneration are no longer justified. Weber further makes special reference to the experience that the marriage of an invalid with a perfectly healthy individual may be followed by the procreation of normal children.

These opposing views cannot at present be harmonised.

It is obvious that if a process of degeneration be really in progress, the importance of hereditary diseases is even greater than would otherwise be the case, and that mankind, under pain of racial destruction, must make all possible efforts to put a stop to the threatening diffusion of

pathological conditions. But even if degeneration be not a fact, if there be no increase in hereditary morbid states, if the number of diseases remain the same apart from any interference of ours, the disadvantages that the existence of these diseases involve are so enormous that we have the greatest possible interest in endeavouring to diminish their prevalence.

CHAPTER VII

CAN DISEASE FAVOUR HUMAN EVOLUTION? TELEOLOGY

SINCE disease, as we showed in the introductory chapter, always involves a diminution in functional capacity, it is not to be expected that that which damages the individual will be likely to favour mankind as a whole. The morbid change which affects any portion of the body remains morbid even if it be transmitted by inheritance through countless generations and to innumerable individuals. It seems conceivable, however, that human beings might, in the course of centuries, become habituated to a pathological state, in the sense that the functional activity that has been depressed in consequence of the existence of that state might be taken over by another organ, so that the changed portion of the body would no longer possess a disease-producing significance. He may imagine that in that case, by persistent inheritance, there might be produced groups of human beings distinguished from the rest of the race by the depressed functional activity of one organ and the increased functional activity of another, thus constituting a peculiar species of mankind. We may ask, therefore, in this connexion, whether diseases do actually lead to the origin of new species, whether they may transform humanity in particular directions, and perchance promote a desirable evolution.

A like assumption has been made in the case of animals. For example, some persons have believed that dachshunds came into existence in this way, that rickets in the first instance caused the characteristic atrophy of the extremities, and that this change was subsequently transmitted by inheritance. This view is erroneous. As von Hansemann

has shown, the peculiar formation of the legs in dachshunds has nothing whatever to do with rickets or with any other disease, and is a characteristic of this particular race of dog on the same footing as the characteristics of other breeds of animals.

On the other hand, the peculiar characteristic of crested fowls and crested tufted ducks, in which there exists a rounded prominence on the head, representing a kind of cerebral hernia, must be regarded as pathological. For in these cases we have a protrusion of the vault of the skull, containing a portion of the brain. It is, indeed, distinguished from cerebral hernia in human beings by the fact that the brain remains covered by a bony wall; there is no hole in the skull through which the cerebral tissue projects. Nevertheless, the condition is altogether morbid, and even though the birds thus affected have a distinctive appearance and seem to constitute a separate race, they must not really be regarded in this way. As compared with individuals that do not exhibit the malformation, they are always below par value, and they manifest all kinds of morbid disturbances. There is no question here of the constitution of a new species.

As regards the human race, we know of no example which can be interpreted in such a sense. Pathological changes remain pathological throughout the generations, and although it is true that certain abnormal conditions, such as hereditary polydactyly, do no particular harm, it will not occur to any one to regard persons thus affected as constituting a separate species. Still less will any one be inclined to see in this malformation a peculiarity favouring the evolution of the race, or the particular group of those who are affected. If these considerations apply to simple and on the whole harmless anomalies, *a fortiori* they will apply to really morbid changes.

While the force of this reasoning cannot be denied, it might still remain possible to regard diseases as occasionally favourable to human evolution in an indirect way.

Reference will perhaps be made to the immunity that ensues upon many of the infectious diseases, constituting a protection against renewed infection. What happens in these cases, however, is, not that the morbid change is lastingly retained so as to become a permanent possession of the individual and his offspring, but that, after complete cure, a modification of the body is established which has no disease-producing significance whatever, but exists in association with a condition of perfect general health. Does the change promote the functional capacity of the individual, and therewith favour the evolution of the human race? This cannot be maintained for a moment. The functional capacity of the immune individual is in no way superior to that of one who remains liable to the disease. As regards certain diseases, however, a further argument is possible. In the case of tuberculosis, for example, predisposition is frequently associated with general bodily weakness. It may be contended that the immune individual, who is more vigorous in body, is endowed with greater functional capacity. This is perfectly true; but if the question arises whether such an individual represents a better evolved form of human being, we must not compare him with the weakly individuals above described. We must ask, on the contrary, whether his non-susceptibility has *per se* raised him to a higher level of functional capacity, and this question we are compelled to answer in the negative.

It is perfectly true, as regards acquired immunity, that the individuals thus distinguished are more permanently valuable for the evolution of the human race than those who remain susceptible to infection, and that the former are therefore of higher value than the latter. But they do not on this account constitute a higher form in any genuine sense, and their immunity would be altogether worthless if the infectious disease did not exist.

Reference may now be made to the following additional considerations. When entire races, or the inhabitants of

entire continents, are exposed for centuries to the incidence of an infectious disease, they acquire in consequence a notable diminution of susceptibility. When the infection recurs they suffer less than those who are exposed for the first time in their history. Experience shows that the infectious diseases of childhood, when introduced to islands where the diseases have hitherto been unknown, prove far more destructive than they do with us.

The less susceptible peoples therefore suffer less than others, and if the former happen to stand at a higher level of civilisation than the latter, it follows that the more valuable elements of the race will be better preserved than the less valuable. But what is the importance of this when compared with the enormous injuries inflicted by the infectious diseases in past centuries, and to be inflicted by them in the future notwithstanding the relative immunity of the peoples among whom they have long prevailed? It would obviously be much better if these diseases did not exist at all. We have also to take into consideration, as regards races, the fact to which allusion was made above as regards individuals, that while it is true that in the case of the comparatively immune peoples the losses inflicted by disease are less severe, their immunity does not advance them to a higher stage of evolution, for if the diseases in question had not existed, they would not merely stand where they do now, but would unquestionably occupy a higher level. For it is indubitable that diseases, with their manifold injurious consequences, have tended to check racial evolution as a whole.

All these arguments lead to the conclusion that the morbid states affecting our bodies, and the changes that remain in our bodies after recovery from these states, may, indeed, under certain conditions, have a permanent and valuable effect, but that they are in no way adapted to lead to the development of any new qualities favourable to human evolution.

We may approach the question in another way if, instead

of considering the conditions of our own time, we contemplate those of the whole organic world throughout the enormous period of its evolution, and ask ourselves what part diseases have played in that evolution, and what part they may still be playing. Starting with the idea that by a change in vital conditions a portion of the individuals exposed to such a change may be led to undergo adaptation, that is to say, that in response to the new environmental influences they may experience certain transformations in some part of the body sufficient to constitute a specific differentiation, whilst other members of the same species, proving incompetent to adapt themselves to the new conditions, may consequently perish, we may maintain that in such a case disease has led to the origin of a species. For those individuals that perished did not do so without reason; their deaths were due to pathological changes which appeared in their bodies in consequence of the new conditions of existence which to them proved insupportable—in other words, they succumbed to some illness. On this line of reasoning it might be maintained that every kind of illness that occurs to-day is competent to lead to the appearance of new specific characteristics, and in this way to favour evolution in general. But it is necessary to point out that the pathological changes did not make their appearance in those individuals that were able to undergo adaptation, but in the others, in those who succumbed because of their failure to undergo adaptation, and that therefore the influence of the pathological processes in promoting evolution was extremely indirect. They operated in this way only, that the inferior elements disappeared and made room for the superior ones. Thus the advance of the latter cannot be said to have occurred as a direct consequence of the illnesses.

We must further remember that such new vital conditions cannot be identified, or even closely compared, with the abnormal influences that we now recognise to be the exciting causes of internal disease. In the general course

of evolution it was changes of temperature, climate, dampness or dryness of soil, a change from life on land to life in the water or the reverse, a change of nutriment, etc., which led to the origin of species, but never the action of those disease-producing micro-organisms which play so great a part in inducing pathological changes to-day. It is true that in earlier stages of evolution micro-organisms may have induced disease, but they cannot have led to the formation of new species. They are not competent to do anything of the kind, and this first of all because they never affect all the individuals of a species simultaneously, as influences must do if they are to effect a selection of individuals competent for adaptation. Further they take effect suddenly, intensely, and transiently, injuring living creatures in such a way as to render them incompetent to habituate themselves to the unfavourable circumstances; and moreover, in view of the relatively rapid course of the diseases in question there is no time for such adaptation to take place. Adaptation is dependent upon a long continued and gradual transformation, and it can therefore occur only when the changed conditions remain in operation without intermission. In the third place, it must be noted that reduced susceptibility to infection, as explained above, does not signify the constitution of a new species, and it is all the more impossible to accept the view that acquirement of immunity has any such significance, inasmuch as we do not know of a single case in which a people exposed to infection, for however many hundred years, has acquired complete and permanent immunity. At longer or shorter intervals epidemics continue to appear.

We conclude that diseases, in the narrower sense of the term, have never been determinative factors in that evolution of the organic world which is characterised by the formation of new and more highly organised species. If, moreover, it be suggested that in over-populated areas the infectious diseases may cause great destruction of life, and

thereby secure for the survivors better conditions of existence, we must draw attention to the fact that this does not *per se* involve the origination of a better type, and further that the disease is not *per se* a direct cause of transformation in the individuals that do not succumb to it.

From whatever side we look at the question we are always led to the same conclusion that diseases have no direct influence upon the physical evolution of the organic world in general or of the human race in particular, and that at most they may here and there indirectly lead to some trifling advantage—an advantage that is, however, quite inconsiderable in comparison with the enormous injury inflicted by illness on our race.

Perhaps the question may be asked whether it is really true that humanity as a whole suffers injury from disease. If we put aside all subjective and personal considerations, and remove to a viewpoint from which we can contemplate the human race as a whole, in its past and future evolution, shall we then receive the impression that diseases interfere with the forward movement of mankind, and shall we be forced to conclude that man would have advanced faster in the past and would advance more effectively in the future if diseases did not exist? Let us suppose that mankind had always been healthy, and would always remain healthy, would the results of this change be purely advantageous? The adverse view is possible. If there were no such thing as illness, if no one died prematurely, if all survived to old age, the world would soon be overcrowded, unless reproduction were retarded to an extraordinary degree. The replacement of human beings would become much less rapid, and a rapid replacement certainly has its uses, because of the continued occurrence of new dispositions and combinations which is its necessary result; and further the percentage of aged people would become much greater, and this would necessarily involve a diminution in the general functional capacity. Such arguments as these may lead to the conclusion that the

endowment of our race with perfect health would not be free from disadvantages, and the attempt might therefore be made to put up with the existence of diseases, and to make the best of them. To such arguments we may reply, first that mankind would certainly learn how to deal with the alleged drawbacks, which are purely theoretical, and secondly that in any case these drawbacks would be far less serious than are the injuries to-day actually inflicted upon mankind by disease. The condition of general good health would certainly be preferable even if it were found to possess a seamy side.

These considerations apart, such a view of illness would never give practical satisfaction. We desire to remain healthy, and we feel disease to be something of a disharmonious nature, of which we wish to rid ourselves. Human beings will therefore always concentrate their attention upon the injuries due to disease, and will remain indifferent or sceptical as to the benefits which, from this lofty standpoint, are alleged to accrue from illness. Such ideas as those we have discussed will not help men to agree to put up with disease. The individual will remain completely indifferent to the possibility that the abolition of disease might involve a less effective evolution of the human race.

But if men will refuse, on the basis of such arguments, to admit that illness has an advantageous side, there is yet another point of view which they may be asked to consider. It is conceivable that pathological states are useful to our race in another way, not because they lead directly or indirectly to changes in bodily organisation, but because they spur us on to all kinds of functional activities which promote our advance in civilisation, functional activities which might be partially or wholly neglected if disease did not exist.

If this were really so, disease might then be supposed to work for good in one way or another, we might speak of its influence in this or in that direction—to employ a word

often misused—as "purposive." Before we proceed, it is necessary to study the precise significance of this term.

When we speak of an organ as having a purposive character we express the opinion that this organ is so constructed as to fulfil in the best possible way the "purpose" for which it exists. What do we mean by purpose, and when are we justified in using the word? Only when we assume that to effect this purpose is or has been the deliberate intention of a personality. Purposes cannot exist unless willed by some intelligent being. This idea is involved in the definition of the term. It follows that only the theist is justified in speaking of purposes in nature, only one who conceives that when God created the world He created it and everything it contains with a definite intention, to fulfil definite purposes, and that he adapted to these purposes the structure of living organisms.

One, however, who regards the universe not as created, but simply as a datum of experience, cannot and must not speak of purposes, or is justified in doing so only in so far as living beings deliberately devote themselves to the attainment of consciously foreseen ends—a faculty almost peculiar to mankind. Yet even those who do not regard the world as created are often inclined to speak of purposes in a more general sense. They say, indeed, that the ordinary crude teleology is far from their minds, and that all they have in view are immanent purposes. What sort of marvels are these? Immanent purposes are purposes contained within the things that are purposed. But as "purposes" they can be contained within these things (it is necessary to insist upon this again) only if at the time the things were created the purposes were introduced by a reflective personality—by God. If we do not mean to imply this, if the purposes are inseparately associated with the things, if they have always been there, if they are immanent, we are using the word purpose in a sense that cannot properly attach to it.

The universe evolves in accordance with certain self-

contained rules. Each antecedant process leads to a consequent, the latter is regarded as the "purpose" of the former; and because the first conditions the second the first is spoken of as "purposive" in relation to the second. Or an organ, such as the eye, is adapted by its structure for vision, and we are told that the eye exists for the purpose of fulfilling this function. Those who use such language fail to take into consideration that inasmuch as the second process is dependent upon the first, the first process must necessarily be adapted to produce this particular end, for were it otherwise the second process could not possibly occur; and they fail to recognise that the eye is necessarily apt for seeing, for otherwise it would not be an eye at all. It is, therefore, a matter of course that a thing is "purposive" for that which it causes or for the function which it performs. It follows that the concept purposive, when used by a scientific thinker, has really no meaning at all, is a purely descriptive and therefore superfluous term, means nothing more than would be equally well expressed by the words "capable-of-existing." Only the theist is justified in maintaining that vision is the purpose for which the eye exists, and that the eye is purposive to this intent; all that the non-theist may say is that the eye possesses the function of vision because it has evolved in this way.

The employment of the word purposive by the non-theist is not merely superfluous but is open to serious objection, for it impairs the consistency of his attitude, and leads people to believe that he has not freed himself from theistic conceptions.

If it be improper to employ the term purposive, it is no less incorrect to speak of things as being "unpurposive." It is obvious that the theist has no right to use such an expression. It is inconceivable that God should have set himself purposes to fulfil and at the same time have created something inconsistent with those purposes. What appears unpurposive to man has some purpose from God's

point of view, although the nature of this purpose is beyond man's understanding. The theist is forced to regard diseases as in some way adapted to fulfil God's purposes. For the theist, therefore, nothing in the universe can be unpurposive, for he must regard everything that exists as purposive in the sight of God. He has no right to introduce his trivial subjective considerations into God's creation!

The man of science, however, has no better justification than the theist for using the term "unpurposive." Whatever exists has come into existence in accordance with evolutionary needs. Consider, for example, the case of the vertical organs of which we hear so much to-day. If these organs are no longer functional, in relation to this functionless condition (which to the theist must seem a part of God's purposes) the atrophy of the organ must be regarded as just as "purposive" as the existence of the eye must be regarded as "purposive" in relation to the function of vision. If diseases lead to death, they too are "purposive" in relation to this unavoidable natural event.

If in the course of our exposition we wish to make use of the current terminology, we shall find it impossible to distinguish between purposive and unpurposive. Everything that exists is "purposive." We see this at once when we attain to the right outlook, and are careful to avoid being biased by man's subjective impressions.

The scientific thinker should, however, avoid using the expression purposive. He must speak objectively, and he fails to do so when he speaks of purpose, for when he does this he subordinates the universe to his own subjective impressions, considering not what actually is but what he conceives in imagination. This is not, indeed, his intention. When he uses the word purposive all he means to imply is that the consequent follows the antecedent in accordance with law, that the structure of an organ precisely corresponds with its function. He knows, moreover, that this function has come into existence through adapta-

familiar statement that genius and mental disorder are very intimately related. In a certain sense this is not difficult to understand. The extremely one-sided development of particular tendencies characteristic of genius is likely to be associated with an abnormal development of other sides of the mental life. If it were true that genius could not exist except in association with such a defective and pathological side of the mind, if the existence of the pathological side were an indispensable condition of the high development of the normal side characteristic of genius, a disease would in fact render possible the highest attainable development of the mental faculties, and would thus be useful to mankind. First of all, however, genius is not found solely in association with disease. Secondly, we should certainly not be prepared to pay for the highest possible mental capacity by the acceptance of all diseases; we should prefer to do without a certain proportion of persons of genius, if thereby we could make all other human beings healthy.

It may further be suggested that the existence of disease has been favourable in many ways to our researches in the domain of natural science. For example, the search for medicaments has led us to acquire a much more precise knowledge of many plants than we should otherwise presumably have gained, and in this way great advantage has certainly accrued to scientific botany.

Similar considerations apply, though to a far less extent, to the manner in which our study of the animal world has been favoured by the existence of disease.

Above all, our knowledge of vegetable and animal organisms has been enormously enriched because many of these organisms are exciting causes of disease, and because we have therefore been led to undertake far more thorough investigations than we should have undertaken had this particular reason not existed. The knowledge thus acquired within the domain of disease has proved of so much significance outside that domain in promoting our

understanding of the general processes of life, that our knowledge of allied, but non-pathogenic organisms has been greatly increased. Thus the interest aroused in micro-organisms as the exciting causes of disease has stimulated the study of micro-organisms in general, and in like manner our interest in the malarial parasites has led us to make a more comprehensive study of all the protozoa.

Our efforts towards the cure of disease have also had a favourable reaction upon biological research. Since many tissues are destroyed by pathological processes, it became desirable to understand in what manner the destroyed elements could be replaced. This was the starting point of comprehensive researches into the process of regeneration. It is true that, long before, the problem had been attacked on purely scientific grounds, but in the interest of therapeutics far more vigorous efforts were subsequently made in this field. In the same connexion the study of the so-called compensatory hypertrophy and that of functional adaptation received a considerable impetus.

Further, the vital processes of the normal body have had much light thrown upon them in consequence of the study of pathological processes, and our knowledge of the normal tissues has in many fields been promoted by a study of morbid changes, and has advanced far more rapidly than would otherwise have been the case.

Chemistry, too, has to thank medicine for much assistance, especially in connexion with the study of medicinal remedies. Many new substances have been produced which would almost certainly have remained unknown but for the existence of the diseases for the cure of which these substances have been artificially manufactured. In this way theoretical chemistry has gained much benefit. No less advantage has been derived from a study of pathologic-chemical processes in the diseased body.

We must not forget that the physical sciences have derived profit from the same source. The applications of electricity, of Röntgen rays and of radium, to the treat-

ment of disease, have involved the acquirement of knowledge which has not been without influence in the domain of physics.

It is, in fact, impossible to deny that pathology has furnished a considerable stimulus to the progress of the natural sciences. But are the advantages so great that we should be willing on their account to pay the price involved in the acceptance of disease? Assuredly not. We would gladly give up the comparatively slight advantages which have accrued to science from the domain of pathology, if in exchange we could secure the benefits of permanent health. The injuries inflicted by diseases are so enormous that the advantages just enumerated hardly count in the other scale. Besides, there are no gains to science dependent upon the existence of disease which would not ultimately have been acquired in other ways.

Again, diseases have led to many improvements in social conditions. When people came to understand that the diffusion of certain diseases was greatly favoured by defective hygiene and bad housing conditions, improvement was demanded in the general interest. It came to be regarded as a matter of great importance to improve the external conditions of life, to secure a good water-supply, to provide sound and uncontaminated food, to attend to drainage and sewage, and (although still very inadequately) to see to the provision of better habitations. Yet it is certainly open to question whether all these things might not have been done even sooner had disease never existed. Beyond question, healthy human beings would speedily have thought of improving the conditions of existence, nor would the means have been lacking, if no more had been devoted to the purpose than the sums now expended in the struggle with disease.

We may finally consider such institutions for the promotion of general welfare as the system of national insurance against individual pecuniary loss through sickness and the national provision of medical treatment. But these in-

stitutions are created expressly to deal with the results of disease, and would be altogether superfluous if disease did not exist.

We see, therefore, that the advantages alleged to accrue to scientific research and to practical life in consequence of the influences of disease are insignificant in comparison with the colossal injuries which disease causes; that many of them would have been attained without this particular stimulus; and that others would be superfluous in the absence of disease. The advantages in question will, therefore, not lead us to slacken our efforts to do all that is possible to secure health for the human race.

CHAPTER VIII

DISEASE AND RELIGION

In the previous chapters we have adduced sufficient evidence to show that diseases inflict an enormous amount of damage upon the individual, the family, the nation, and posterity, and that they entail no compensating advantages worth mentioning. It is true in the account just given of the relationships between disease and the future bodily and mental development of the human race, between disease and the individual sciences, and between disease and social problems, we have seen that, occasionally and within narrow limits, diseases may exercise a stimulating and progressive influence; but we have also learned that the losses greatly exceed the gains. We have, however, not yet discussed the extremely important relationship of diseases to religious views. It was impossible to consider this matter adequately within the limits of the foregoing chapter, and we propose to devote the present chapter to an independent and thorough examination of the question.

If there is one thing more than all others likely to turn man's thoughts towards the problem of the meaning of his existence and the nature of his relationship to the universe, it is the fact that disease so often puts a premature term to his career and so frequently inflicts upon him severe suffering. We might even regard this direction of human speculation as the most important service we owe to disease. If it be, indeed, one of man's chief duties to gain a clear understanding as to his position in the universe, and if the existence of disease lead him to attack this problem seriously and to solve it wherever possible, undoubtedly great benefit must be derived. We have, then,

to ask whether diseases are really indispensable to induce men to occupy themselves with such problems, and whether a consideration of diseases is likely to lead us to a clear understanding of the matter. Would not the healthy human being also devote his attention to the problem? Unquestionably he would. The infinite complexity of nature is ever imposing new riddles, and urging us to attempt their solution. By a profound inner impulse, man strives towards knowledge; this impulse is inborn; it is one we cannot but obey. Nor can it be doubted for a moment that the healthy individual is far better fitted for the acquirement of knowledge than the invalid, whose attention is claimed by his own condition, who thinks exclusively of his own personal interest, who is indifferent to the outer world except in so far as this bears upon his illness, whose mental functions are confused or one-sided or are affected and restricted through bodily suffering. It is obvious that the sick man will be less successful in the pursuit of knowledge than the healthy one, for the former, especially in the case of mental disorder, is really incapable of contributing anything of value towards the solution of such problems. His abnormal state imposes every kind of hindrance and leads him to false conclusions. Anything which one who is not completely normal in his mental life, anything which a person who is markedly onesided in the sense explained early in this book, believes himself to have discovered, must be accepted with extreme caution. Of what use is it that disease should furnish a stimulus towards the solution of the problem of existence, however great this stimulus may be, if by the very fact that he is diseased the invalid is deprived of the capacity for attaining to a satisfactory understanding of these problems? The invalid's conclusions may be satisfactory to his own mind, but they are meaningless as regards the general advance of our race, and will often lead astray. Only the healthy man, the logical thinker who gives due weight to all relevant considerations, can count upon attaining to satisfactory conclusions.

The matter may, however, be approached from another point of view. Even if it be true that as far as invalids themselves are concerned the effects of the diseases from which they suffer are purely disadvantageous, if their illness serve only to prevent the attainment of a solution of the very problems which that illness leads the invalids to propound, it may still remain true that the occurrence of disease leads healthy individuals to devote more attention to the problems of existence than would otherwise be the case. This is actually so. By the suffering and premature death of his fellows the healthy individual is urged in the suggested direction, and we cannot deny that the impulse towards knowledge is thereby strengthened, and that the acquirement of valuable results may be accelerated in consequence. Before, however, agreeing to see therein an important beneficial result of disease, we must consider two objections. First of all, the healthy individual's judgment will be less independent than might be supposed. His judgment will be more or less obscured by sympathy, by his participation in the other's suffering. Secondly we have to ask whether we should be willing, in view of the benefits under consideration, merely in order to obtain a better insight into the relationships of things, or rather merely in order to have our attention more keenly directed to these relationships, to accept all the misery and distress resulting from disease. It cannot be doubted that we should refuse any such bargain. The profits bear no reasonable comparison with the losses. Nor must we forget that in consequence of the diseased or abnormal condition of the majority of human beings an immeasurable quantity of mental faculty runs to waste. Among all these invalids there must be many who, had they been healthy, would have been competent for far more extensive mental collaboration, and in this way would have contributed to human advance to a degree far greater than that which corresponds to the advance now effected by the mental labours of healthy individuals in consequence of the stimulus

which these experience owing to the existence of disease. We may definitely assert that had human beings always been healthy we should be further advanced than we are at present in our understanding of the nature of things. Perfectly clear reflection, neither restricted nor enfeebled by any pathological manifestations, would certainly have brought us beyond our present stage of knowledge. Many wrong turnings would have been avoided.

For example, there can be no doubt that diseases have had a great influence in the origination of the pessimistic view of life, above all because illness is apparent on all hands, and seems inseparably associated with the existence of living organisms. How can a world be good which is thus permeated by disease? Human beings apart, we see everywhere conditions which with more or less justification (a matter to be discussed in the concluding chapter) are regarded as pathological, such as the permanent destruction of enormous numbers of undeveloped living beings. But human pathology is here chiefly determinative, for it is this that especially forces itself upon our attention. Disease is regarded as inseparable from human existence, as from the existence of the entire organic world, and this leads to pessimism. But are we really justified in considering disease as an essential characteristic of the human race? Can we not conceive of disease as non-existent, without man's thereby being deprived of anything that truly goes to make him man? We can certainly do this. We can very well imagine that all human beings might be healthy, and we may actually hope that in the future the prevalence of disease will continually diminish. In these circumstances, are we justified in allowing the existence of disease to exercise a decisive influence upon our general view of the universe? Would it not be more correct to base our judgment solely upon the contemplation of health, and to deduce therefrom an optimistic view of the universe?

It is not merely the objective contemplation of disease

which has led to pessimism. Subjective considerations also exercise an influence in this direction. A man's own morbid state will affect his views, and will often give these a pessimistic tinge. To induce this it is not necessary that there should be an illness causing bodily suffering, nor yet that there should have occurred a one-sided mental development, for the mere possession of a high degree of sensibility, leading its possessor to overestimate the importance of his own minor troubles and those of others, will lead to pessimism. There may also exist in certain human beings an inborn temperamental tendency which leads them to see everything in gloomy colours. In contradistinction with such persons, the perfectly healthy man is quite free from any inclination to pessimism (and the same is often true of those who, though physically ill, are mentally normal). Even if on occasions healthy humanity may feel somewhat gloomy because illnesses continue to exist, still the natural inclination will always be to take an optimistic view of life. The world is full of unending beauties, and in the absence of any morbid disturbance this must necessarily lead to optimism.

Even in this age in which diseases exist, the reflective human being cannot take other than an optimistic view. That which arises from disease cannot be normal, and has therefore no right to influence our general attitude towards life. Disease is produced by disease, and pessimism is therefore morbid.

It is sometimes contended that we cannot escape from pessimism because diseases are a necessary appurtenance of humanity. It is true, we are told, that we can conceive diseases as non-existent, but in actual fact we cannot separate them from the general evolutionary process, we have to take them into account, and thus we are constrained towards pessimism. But this merely involves an admission which no one proposes to dispute that the existence of disease is mainly responsible for the origination of the pessimistic view of life. This brings us back to our start-

ing point. But it is wrong to regard disease as an inevitable and integral accessory of life. In the case of human beings, disease is certainly not necessary, for many diseases are obviously preventible. This point will be considered later.

Let us now proceed with our discussion of the significance of diseases in relation to the solution of the problems of existence. Just now we were forced to the conclusion that as far as concerns our understanding of man's place in the universe, disease does more harm than is compensated by any good that may ensue from the stimulus to scientific research afforded by its existence. But there is another aspect in which the significance of disease may be regarded as more considerable, for its existence furnishes a far more powerful stimulus to the emotional than it does to the intellectual side of our nature—taking the term emotional in its most comprehensive sense to include our religious views of life. Through disease, the question of the personal relationship of the individual to the world-all, the problem of human destiny, is forced to the front. This may be supposed to involve a notable advantage. It may be contended that the indifference displayed by many persons towards religious problems, and their deliberate avoidance of the consideration of such questions, are deplorable. But this attitude would be greatly accentuated were it not that through illness people are often rudely compelled to pay attention to these problems, forced to give them respectful consideration, and this, we are assured, is a benefit we owe to disease, one which even the scientific thinker cannot fail to recognise. For men of science cannot escape the problems of religion. One who has not thought them out, one who has failed to come to terms with their difficulties, can never find secure standing ground. He must settle his account with religion. Among those who ultimately find complete satisfaction through exclusive absorption in the domain of scientific ideas, there is certainly no one but has felt the need to touch upon

the religious sphere (always understanding the term religion in its widest possible signification) and to become clear as to his own attitude towards religious problems.

By these considerations we are led to recognise that diseases tend to turn men's minds to the problems of religion. For this reason, perhaps, many will have endeavoured to put up with the existence of illness, and to believe that it entails more benefit than disadvantage. But such a view would be justified only if we were compelled to assume that if there were no such thing as disease men would not concern themselves about religious problems. We cannot for a moment accept such a view. On the contrary, it is beyond question that even if human beings were perfectly healthy they would none the less state religious problems and do their best to solve them. The stimulus furnished by the existence of disease is superfluous.

In the second place, it must not be forgotten that a healthy humanity would find a much more satisfying answer to this question than is possible to our race when afflicted as now by disease. It is obvious that in religious matters, as in others, a healthy human being feels and judges more accurately than a diseased, or than one who is influenced and confused in consequence of the illness of others. Trouble and anxiety such as are caused by illness and premature death necessarily cloud the judgment, and in this way the advantage ascribed to illness, because it turns our thoughts to religious questions, is counterbalanced, and indeed enormously outweighed, by the disadvantages that ensue from the great limitations imposed thereby upon our rational faculties. It follows that for the solution of these problems the general effect of illness is simply injurious.

Yet there can be no doubt that disease is to-day responsible for the intensity with which most people devote themselves to religious questions. Illness and premature death continually recall the thoughts to the problem of human destiny.

When we see that most persons die an unnatural death, when so many succumb before the onset of old age, often long before, and frequently in early childhood, when many suffer from illnesses of a more or less serious and painful character lasting for years and even decades, while others through the whole of a long life have hardly a moment in which they are not aware of their morbid state,—the question arises what meaning there can be in a life which is thus dominated by disease. How can we accept with equanimity that the individual's lot should be so extraordinarily variable, that one should suffer without cessation while another is always in vigorous health, that one should attain old age while another succumbs prematurely?

For most people these and similar considerations are decisive. They ask themselves whether a life which, on account of illness, has offered them little or nothing of the good things which others have enjoyed, can really end with death, whether there is not to be a continuation in which will be provided a compensation, a happiness to make up for that which is here denied to the invalid. These anxious questionings are answered by the religious systems, which hold out the prospect of a happy eternal life compensating for all the sufferings endured on earth. Most people accept this prospect as certain. Invalids do not indeed appear to realise that when they enter into eternal happiness the balance of advantage will still remain on the side of the healthy, for the sum of sickness and happiness is always less than the sum of health and happiness. The individual, therefore, can never be fully satisfied by the explanation that illnesses exist in order to direct people's thoughts to the life beyond the grave in which compensation will be provided for those who suffer on earth. Sickly people will always have the right to ask why they in particular should have been selected to suffer on earth, and to this the only possible answer is that God's ways are inscrutable.

For the scientific thinker such ideas have no cogency.

From the outlook of science, diseases, like all other natural processes, are necessary phenomena which have arisen in the course of the evolution of the organic world out of the conflict between individual organisms and environmental conditions, out of the struggle for existence. In the view of the man of science, diseases, like all other phenomena, must be judged from a purely objective standpoint. He can find nothing in the existence of disease which is in any way relevant to the future. He regards diseases as occurrences extremely unfavourable to the life and the evolution of the human race, and he labours to prevent them by all the means at his disposal. He knows that the dread of premature death has a paralysing influence upon human activities, rendering men incompetent to devote themselves wholeheartedly to the purposes of life, and incompetent to live deliberately and unreservedly for themselves and for their fellows. But the fear in question depends upon the existence of disease and the occurrence of premature death. Every one, therefore, who wishes to allay this paralysing fear, as must every one who has at heart the progress of humanity, will urgently desire to do all in his power to put an end to disease. To the scientific thinker, illness is simply a disadvantageous phenomenon whose cessation would lead to an untold expansion of our racial activities. Perfect bodily and mental health is therefore the goal towards which he strives.

At first sight it might appear contradictory that we should attempt to attain the ideal of universal health, seeing that we have just said that diseases are necessary phenomena arising out of the struggle with environmental conditions. It is useless, we shall be told, to struggle against them, since they are inseparably associated with the evolutionary process. But this applies to the past only. Diseases can be regarded as inseparable elements of the human evolutionary process only so long as man fails to initiate a deliberate endeavour to free himself from them by the removal of the unfavourable environmental condi-

tions which have caused them, thus conducting the struggle for existence into paths of his own choosing. When he becomes enabled to favour his own evolutionary process in this manner, diseases can no longer be regarded as necessary constituents of his existence. From the altitude of insight to which he has now attained man is enabled to see that diseases are the outcome of unfavourable environmental influences, and that to an increasing extent he is becoming competent to obviate such injurious influences. Directly he understands this, he recognises the inevitability of the fight against disease. Insight into the relationships between himself and disease is a product of the evolutionary process as it runs its course in himself and in humanity at large. In proportion as, in virtue of this process, which is in all respects necessary and proceeds according to law, man's intellectual faculties are perfected, men come more and more to recognise that diseases are not essential elements of their nature, but are forced on them from without. This recognition, in turn, inevitably leads to the campaign against disease. If hitherto disease has been a necessary and inseparable accompaniment of the general course of evolution, the repression of disease has now become no less necessary and inevitable.

Thus the desire to do away with disease is in perfect harmony with the process of human evolution. Humanity will therefore strive by all possible means to put an end to pathological states, and will work more actively to this end in proportion as advance is made in the direction of its attainment. For as that advance is effected men will feel ever more keenly the tragedy of their present condition, the abolition of which is the sublimest task of our race. If the ideal of universal health were ever attained, it would no longer be disease and premature death, but simply the normal life of mankind that would determine men's conceptions of their relationship to the universe. Then man would be freed from all the disadvantages—and they are many—which are entailed upon our

race by the now dominant religious systems in so far as the doctrines of these are the outcome of the existence of disease. If the religions did no more than to gratify with hopes for the future, all those individuals who feel the need for such hopes, if they merely endeavoured to help people with the idea that in some alluring future beyond the grave there will be found compensation for illness and premature death, no one need offer any objection.

But the religious systems are not satisfied with the inculcation of such wide general views. They do not ask merely that the thoughts of sick persons should be turned in the religious direction, but they insist upon the acceptance of definite creeds. They tell us that a happy life is possible only through the observance of certain strict religious commandments, and that we must believe all their doctrines with as little reflection as possible on our own part. The invalids who fear death, and those who see the sufferings of their fellow men and upon whom similar fears are thereby imposed, yield to their demands. Thus men are brought to believe in the rigid dogmas of orthodoxy, whose strongest props are diseases. Without this support, the dogmas would crumble away.

It may here be suggested that we have no right, in this connexion, to think of illness alone. All the other kinds of human suffering furnish an impulse to religious thought. More particularly is this true of the tragical social conditions that arise from poverty. But how does poverty come into existence? It arises in great part because disease has prevailed in the family, because one or both parents have fallen ill, and are therefore unable to earn their bread, or because one or several children are ill. To a still greater extent poverty ensues because persons have a defective intellectual equipment, are not completely normal, and are therefore incompetent to cope with unfavourable conditions. Thus it will be seen that disease and abnormal mental predisposition play a large part in the causation of the sufferings consequent upon poverty.

We must, indeed, admit that there are some persons who remain poor, or become poor, owing to unfavourable external conditions among which illness or mental abnormality plays no part. But in such cases is it really the insufficiency of the means of life that *per se* turns the mind towards religion? Is not this direction of the thoughts due rather to the fact that body and mind have been injured by insufficient and erroneous nutrition, and have thus become diseased? Unquestionably this is so. Starvation and underfeeding, even if they do not induce actual disease, similarly impair the human faculties, and the unceasing cares of existence and the need of a man's dependents are a continued source of irritation, leading to mental abnormality, and gravely impairing the powers of resistance. Thus where there is poverty or destitution men's thoughts and feelings are determined by bodily and mental abnormality.

We must therefore reiterate that it is a state of disease which leads human beings to take refuge under the shelter of dogmatic systems.

These systems are thus dependent upon disease. There can be no doubt that most of their adherents accept them mainly because they hope to find in them relief from the anxieties aroused by disease and death, and because on the average they do actually find such relief. With the cessation of disease there would be removed a powerful motive which now leads men to turn towards dogmatic religion. It is unquestionable that if men were all healthy they would be much less concerned than they are at present, and perhaps not concerned at all, about the question of life after death; certainly they would not trouble themselves about dogmatic teachings, which have been born solely out of the fear of premature death. Death in old age, as the painless end of a healthy life, would no longer make a powerful impression on the mind. Such a death would not be feared, whereas death as we know it to-day, usually premature, induced by disease, and preceded by

severe suffering, is the cause of much disquiet. When our race has attained health, the thought of what is beyond death will not trouble the old man who looks back from the end of a happily completed life; such a one will simply desire the peace of death. This is what we commonly see even to-day in old age; and we should see it still more frequently were it not that from youth upwards people's minds are perpetually redirected towards orthodox views by the force of current teaching and by the premature deaths of their associates. When all men are healthy and when death occurs solely in old age, the interest in dogmatic religious teachings will decline and disappear. Even as things are, the relatives of one who dies in advanced age hardly ever regard this event as an occasion for religious reflections. They view an old man's death primarily as a release from the troubles of old age. They consider such a death to be a natural process, and see in it no ground for complaint.

If all human beings were perfectly healthy, or in other words if there were no illness, the perfect normality of our condition would allay the fear of death, and therewith would remove the principal cause of anxiety about a life beyond the grave. Even the consideration of possible eternal punishment for evil deeds and thoughts would lose its terrors, for the healthy human being, harmoniously developed, could no longer perform acts which could be described as evil in the sense of existing religious doctrines. Acts of this character (see p. 40) are the outcome solely of a morbid condition, or at any rate of one that is not perfectly normal. The man who is thoroughly healthy in every respect simply cannot act badly or wickedly; his actions are necessarily good, necessarily, that is to say, properly adapted to the evolution of the human race, in harmony with the cosmos. Man would therefore have no occasion to dread such punishments beyond the grave as dogmatic religion is accustomed to depict for us to-day; the idea of expecting rewards and punishments

after death is one which would never enter his mind. For this reason he would be altogether inaccessible to orthodox religious views.

If the disappearance of disease will thus diminish or remove anxiety about the life beyond, the adherents of the dogmatic systems cannot logically be expected to desire that the existing morbid condition of our race should be replaced by a healthy one, for should this happen the number of the faithful would continually diminish. In this matter, however, men's desires are stronger than the interests of dogma. Every one strives to be healthy, and even the strictest advocates of the orthodox views do not differ in this respect from their fellow men. But if the abolition of disease should ever be successfully accomplished, in the healthy human being the need for rigid dogmatic religious ideas would become less and less conspicuous, and the religious systems would spontaneously tend to grow less dogmatic.

For the present, indeed, dogma still dominates, and the adherents of dogma will do their best to maintain its dominion. It cannot be doubted that they will succeed. The great majority of men will continue to cleave to dogma; some because their intellectual powers are inadequate to enable them to regard disease objectively, others because they are not inclined to do this, being influenced by the contemplation of their own and others' suffering and by the sight of premature death; they are thus led to accept dogma with its peculiar attitude towards death and its promise of a life beyond the grave. For these reasons the empire of dogma will be long-enduring, and the power of the orthodox systems will not soon be broken. If all that dogma affected were simply to provide consolation for those who to-day accept dogma, for those who without dogma could not find satisfaction or would be positively unhappy, to make them unrepiningly accept the existence of illness and consequent poverty, this influence is one we could not fail to welcome. The freethinker would have

no interest in depriving of this solace those who can find it only in dogmatic teachings. Enlightenment at any cost can be the aim of those alone who are dogmatists in their turn, and are therefore just as one-sided as the advocates of the rigid religious systems.

While, however, within its own domain, dogma may be of advantage to many persons, we cannot admit the claim made by the adherents of dogma that all those ought to accept it who have in actual fact cast off its shackles, and who have come to regard diseases simply as phenomena existing in accordance with natural law. Those who take this latter view have just as much right to their own opinion as the dogmatists. They must demand that all men, whatever religious views they may hold, should possess exactly the same rights in private and public life. If this were granted, how much would be gained even to-day, when diseases and dogmas are still in power. But we are as yet far from this consummation, for the orthodox systems will not admit any such claim.

Dogma is essentially intolerant. It lies in its very nature, not merely to reject all other views than its own, but to fight against them energetically. Thus arise conflicts characterised by extreme violence.

We do not mean to imply that all adherents of dogma must as individuals necessarily be intolerant. For dogma is foreign to man's nature, and not in every one is the love of dogmatising so keen as to lead to the suppression of our instinctive desire to live at peace with our fellow men. Many, however, are intolerant. Some because they want to convert every one else to the opinion that seems to them the only right one, forgetting that belief is subjective in character and cannot be constrained. Others, and these unfortunately are very numerous, are intolerant from lack of sympathy, hatred, love of dominion, and other unworthy motives—and above all because they are not perfectly normal or because they are definitely diseased.

Further discussion of intolerance and its disastrous consequences is outside the scope of this work. The significance of dogma is known to all. We may simply refer to the history of the inquisition, to the persecution of heretics and Jews, to the fierce struggles between the adherents of the different creeds, to the disunion sown by divergent dogmas in the nation and in the family. Such consequences are matters of everyday experience. They serve more than all else to poison the springs of private and of public life, and to rend humanity asunder.

The ultimate cause of such deplorable intolerance is the existence of disease and of premature death. Without these there would be no dogma, and without dogma there would be no intolerance. Thus from this point of view also a campaign for the abolition of disease is seen to be absolutely essential. Religious peace on the foundation of undogmatic views will not be attained until disease has been greatly restricted in extent or has altogether disappeared.

CHAPTER IX

THE ABOLITION OF DISEASE. RACIAL HYGIENE

At the close of the sixth chapter we said it was questionable whether there was any serious reason to dread the much-discussed danger that the human race is undergoing degeneration, but we added that even if this danger be imaginary we must none the less do everything in our power to effect the abolition of disease. The whole course of this discussion has shown us that the injuries inflicted by disease are enormous and that they cannot possibly be overestimated. Even if diseases should not become more frequent than they are to-day, their continued prevalence would greatly interfere with the future evolution of our race. For this reason the campaign against disease is a duty. What steps can we take to this end?

It is obvious that we must devote our attention above all to the abolition of hereditary morbid states. These are by far the most important in relation to human evolution, because they affect men throughout the whole of life, because their association with life is so intimate that they seem as it were to become a part of our being, because they touch us so intimately, and because they may be transmitted by us to our offspring. If the alleged racial degeneration were really in progress, this must depend upon hereditary diseases, for other diseases would come into the question only so far as they were qualified to give rise to new transmissible pathological characteristics. As far, however, as the welfare of each generation is concerned, the individual diseases also play a great part.

When we speak of doing away with illnesses we com-

monly think first of all of their cure. But cure comes in question only as regards non-hereditary infections, and unfortunately only as regards a minority of these. It is true that there are many illnesses in which so complete a cure may result that often not the least trace remains; this applies to the acute infectious diseases, acute pneumonia, typhoid, the infectious diseases of childhood, wound-infections, injuries, etc. Yet we all know that even as far as these diseases are concerned not a few attacks end in death, and that even if recovery occurs it is by no means rare for some morbid condition to remain as a sequel. There are many other diseases in which recovery does not take place, or is quite exceptional, for example, valvular disease of the heart, contracting kidney, calcification of the arteries, the malignant tumours, severe tuberculosis, etc. By these diseases, moreover, because their course is usually a long one, and because the functional activity of those affected is seriously impaired or completely arrested, humanity is far more seriously injured than by acute curable illnesses, for the latter, though absolutely more frequent than the others, are relatively transient in duration.

As regards all these maladies, our principal task is prevention. Since in the case of most of them we have to do with infectious diseases and their consequences, or with intoxications, it must be our aim to ward off the attacks of micro-organisms and to avoid the ingestion of poisons. In this matter of prophylaxis, as we term it, we have made much progress, at any rate in the case of some of the infectious diseases. Typhoid and cholera have become much rarer, having been almost suppressed in northern Europe, and the frequency of tuberculosis has been somewhat reduced.

Hereditary morbid states must however also be numbered among the incurable diseases. Since they are affections of the germ, and are therefore rooted in the individual's constitution, they are beyond the physician's in-

fluence. Congenital malformation, colour-blindness, haemophilia, hereditary diabetes, hereditary gout, inherited mental disorder, and the various other pathological conditions handed down from progenitors to offspring, are beyond cure. If such diseases were really increasing in prevalence and thus leading to the degeneration of our race, therapeutics would be impotent in the matter.

Since this is so we must adopt other methods. First of all we have to consider the possibility of preventing as far as may be the new appearance of hereditary diseases. To this end we must employ in part the same means that we employ against accidental diseases, means which have already been described, for the acute infectious processes are competent to injure the germinal cells. Their prevention would obviate this danger, and thus a number of hereditary abnormal conditions would cease to be produced. Think, for example, of syphilis, whose effect upon the germinal cells experience shows to be extremely injurious. Thus a perfected system of hygiene would serve to prevent, not merely the acute diseases, but also the occurrence of injuries to the germ. We have shown above (p. 178) that there is no danger that this would have the effect of removing a valuable selective influence. Nor, in this connexion, must we confine our attention to the infectious diseases. It is necessary to refer once more to alcohol, the influence of which in poisoning the germ, an influence whose importance is variously estimated, was discussed in an earlier chapter (p. 161). In view of these hereditary possibilities, we must do our utmost to put a stop to the misuse of alcohol. In this respect the state and the community-at-large have important duties to fulfil.

In these fields of prophylaxis much can unquestionably be done to diminish the prevalence of hereditary morbid tendencies, although the attainment of our aims in this respect will be slowly effected. In this way, however, a part only of our task will be performed. A no less important part remains, namely, to prevent procreation by

persons who are affected with severe inheritable diseases. I emphasise the term severe, for it is upon the severe cases that we must first concentrate attention. It would be a mistake to divide our forces. As regards colour-blindness, shortsightedness, the minor malformations, and the like, we shall have no useful opportunity of limiting procreative activity. We are primarily concerned with graver conditions, those that make the individual affected with them worthless, useless, and a positive danger to his fellows, such as the different forms of mental disease and of criminality. We should aim at excluding from reproduction, not only those who are already themselves ill in the sense just defined, but those also who, though not themselves severely affected, are in a condition which involves the danger of such injury of the germinal cells and therewith to the offspring as is likely to result in these latter being affected with mental disorder. We think here especially of drunkards. Even if we do not regard as proved all the evils that have been laid to the charge of alcohol, still no one can doubt that the persistent soaking of the body with this poison must involve injury to the germinal cells.

What are we able to do in the way of preventing procreation?

Much is effected by certain measures which are not undertaken in the express aim of preventing reproductive activity, as, for example, by the permanent seclusion of lunatics in asylums and the confinement of criminals in prisons and penitentiaries. Such means, however, are inadequate. Many mental disorders develop slowly, and the persons affected with these may have children before they are placed under restraint. Since, however, the morbid condition already affects their germinal cells, they transmit the taint at a period when they themselves still appear healthy. Other persons suffering from mental disorder are discharged from institutions although they are not cured in the proper sense of the term, whilst others live always with their families. Criminals for the most

part are confined for a time merely, and can reproduce their kind as soon as they are set at liberty. If, therefore, we wished to attain our end by means of the segregation of tainted individuals, the only course open to us would be the permanent seclusion of all those affected with severe mental disorder, and of all the criminals who have taken to criminal courses because they have developed from diseased germinal cells, so that we must suppose the germinal cells in their bodies to be also tainted.

Another proposal that has been made is that such mental invalids should not be locked up, but that, in so far as they are suited (as are criminals) for the application of this method, they should be deported to colonies where (since the sexes will be segregated) they will have no opportunity of reproducing their kind.

Especially effective is the practice of castration in males and of oöphorectomy in females, that is to say the operative removal of the reproductive glands; or simple sterilisation by a much easier and less severe operation, the division of the canals by which the germinal cells are discharged, the Fallopian tubes in women and the vasa deferentia in men. In some of the states of the American union such operations have been practised, in certain cases on criminals exclusively, but in others also on imbeciles and the weak-minded. In the State of Indiana, according to a report by Hans W. Maier, at the end of July, 1911, 873 persons had been sterilised by operation. In Switzerland, also, as we learn from Oberholzer, a beginning has been made in the adoption of such measures.

We must further consider the question of prohibiting marriage in the case of all persons who suffer from severe hereditary disorders. Many of the states of the American union have set a good example in this respect. Maier informs us that marriage laws of this character have been passed in Connecticut, Michigan, Ohio, Kansas, New Jersey and Minnesota. These laws deal especially with lunatics, epileptics, the feeble-minded, and drunkards, to some

extent even where the affection no longer remains active, but where there is danger of relapse or of the existence of simultaneous disease of the germinal cells. In Michigan it is also a punishable offence to assist in the marriage of individuals suffering from inheritable disease.

All such endeavours for the diminution of hereditary disease find numerous advocates in Germany, England, and throughout northern Europe. In Germany those who favour these aims have formed a Society for the Promotion of Racial Hygiene (*Gesellschaft für Rassenhygiene*). Its activities centre in Munich, and its president is Dr. Ploetz. The scientific aspect of the matter is discussed in the *Archiv für Rassen- und Gesellschaftsbiologie,* now in its tenth year of issue. In England the first concrete expression of the tendency to promote racial hygiene was the work of Francis Galton, to whom we owe the term "eugenics." There exists in London a Eugenics Laboratory, and by this institution have been issued the researches into inheritance, and the detailed pedigrees, to which allusion has several times been made, contained in *A Treasury of Human Inheritance.* An international association has been formed to co-ordinate the activities of the advocates of racial hygiene in the various countries we have named.

We owe to Schallmeyer a remarkable work dealing with all these questions which was published in the year 1910 under the title *Vererbung und Auslese* (*Heredity and Selection*).

All such efforts to limit the prevalence of hereditarily transmissible diseases deserve cordial support. No one who is interested in the further advance of human evolution should neglect this field of activity.

Unfortunately, however, the goal is less easy to attain than might at first sight appear. For, first of all, the considerations upon which action is based have not yet permeated those circles which are chiefly responsible for legislation. In European countries there is at present hardly any prospect of measures to deal with the danger of the

hereditary transmission of severe mental disorder and criminal tendencies. Nor is there any near prospect of the institution of marriage prohibitions similar to those that exist in some of the United States. A considerable time must elapse before the Society for Racial Hygiene will have been able to disseminate its ideas through wide circles. At present among the general public there unfortunately exists very little serious inclination to accept the imposition of any kind of legislative restriction upon the procreation of children, although—and here the same circle of ideas is really involved—errors of omission in the way of the deliberate limitation of the family are extraordinarily widespread. In this matter also we have to recognise an indication of the comparative worthlessness of innumerable human beings. We cannot regard as normal individuals those who restrict the procreation of children on the ground of convenience. The woman's movement also is partly to blame for this. One-sided, extreme, and therefore abnormal advocates of woman's emancipation commonly renounce marriage, and therewith refuse to undertake woman's chief duty, that of motherhood.

It is true that the limitation of the family has been advocated for other reasons, which in many cases, however, are certainly no more than a mask for the personal convenience of the parents. The neomalthusian doctrine refers to the danger of over-population, and to the fact that when there are too many children in a family extreme poverty is apt to ensue. We cannot consider this matter here, and will merely point out that the superficial and uncritical manner in which the demand for the limitation of the family is voiced on all hands involves a grave danger to human evolution. The danger consists in this, that too small a number of vigorous offspring will be procreated. Interference with procreation on such lines is justified in so far as its aim is to prevent the exercise of reproductive activity by badly qualified parents, but it is altogether without justification in so far as it influences those

individuals who are in all respects apt for procreation, and who, precisely in consequence of their healthy constitution, are also fully competent to rear a large family with success. One of the important tasks of racial hygiene is to see to it that such parents shall not procreate too small a number of children, to ensure, that is to say, that in such instances the neomalthusian doctrine shall not find practical application. The limitation of the family must not be pursued in this uncritical manner. The system must be applied only in the case of individuals affected with hereditary disease. Here, however, the application must be radical. Hereditary invalids should have no children at all. But such an end is attainable only through marriage prohibitions, although not completely even by these.

We have already pointed out that the time is not yet ripe for legislation. Objection to such measures is often raised on the ground that our scientific knowledge of heredity is not sufficiently full and accurate to furnish us with firm grounds for action. If we are to prevent procreation we must have positive assurance that the offspring, if conceived, would really be diseased. In default of such certainty, we are not justified in instituting prohibitions. This is obvious. In actual fact, our knowledge of the laws of heredity, especially as regards disease, is inadequate, and we have to admit, as a fact of general experience, that the children of diseased persons are by no means all necessarily diseased. It may be pointed out that in accordance with the law of the segregation of characters we often find that not more than one half of the children become ill. Hence, we are told, we have no right to interfere with procreation. But is it contended, we must ask, that the healthy children and the diseased weigh down the scales equally? Is it not rather true that the disadvantages entailed by the existence of the diseased are far greater than the advantages entailed by the existence of the healthy offspring? Do not the sickly children constitute a permanent reproach to the parents, so that the fact

that some of their offspring are healthy cannot suffice to absolve the parents from blame?

Moreover, Mendelian segregation is valid as regards a part only of hereditary conditions. It occurs in the less severe types of disease, and in those that are of less importance from the point of view of degeneration, such as the minor anomalies and malformations. It is seen also in hemophilia, diabetes, and (according to the latest evidence) in certain mental disorders as well. But, as far as our present knowledge goes, segregation does not occur in the case of the most severe forms of mental disorder and in that of hereditary tendencies to crime. In such instances it often happens that all the offspring are abnormal, although in varying degrees, so that it would seem that the separation of the diseased from the healthy character has here been difficult to effect. This may possibly depend upon the fact that whereas in slighter cases only a single organ undergoes morbid change, in these severe forms of germinal intoxication the whole body is diseased. If this be so, complete segregation will far less easily occur. If we conceive that the germinal intoxication has affected a whole series of separate characters, and if we imagine that when segregation occurs each of these characters behaves independently, the result is likely to be that instead of all the normal rudiments entering one germinal cell and all the abnormal rudiments another, one germinal cell will receive some morbid characters while another germinal cell will receive others. This would explain why it is that all the offspring are diseased, but that they are affected in different ways.

The absolute prohibition of procreation is obviously necessary in all cases in which complete segregation does not occur. For as far as these instances are concerned there is lacking even the questionable excuse that some of the offspring may possibly remain healthy.

But supposing that among the offspring of diseased progenitors of any particular generation not all are diseased,

what should the healthy individuals do? In view of the experience noted above (p. 132) that in the case of direct inheritance (inheritance without skipping a generation) the offspring of those children not themselves diseased often remain permanently healthy, may not such persons marry without anxiety? In those diseases in which complete segregation is the rule there is certainly no harm in this. As we have just seen, however, it is not these diseases with which we are chiefly concerned in connexion with degeneration. In the more serious forms of germinal intoxication the danger is ever present that the non-affected members of the family may harbour the disease in a latent state, for the reason that the segregation of characters has not been complete, so that some abnormal character or other remains attached to the germ without manifesting its presence either in the individuals themselves or in their immediate offspring. In subsequent generations, however, this character once more becomes manifest. We shall understand this without difficulty if we recall that in the case of hemophilia the female members of the affected family carry the anomaly in their germinal cells and transmit it to their male children without personally suffering from the disease. Hence when we have to do with germinal intoxications each individual case must be examined on its merits.

The opponents of marriage prohibitions will tell us that the marriage of members of diseased families with the members of healthy families is permissible, because experience has shown that the healthy condition may be competent to extinguish the diseased. It is true that this occurs, but by no means as a rule. It suffices to point out that the female members of families affected with hemophilia when married to healthy men procreate children who suffer from this disease. In such marriages, therefore, it is impossible to count upon the extinction of the morbid state.

Still more necessary is it to forbid marriage when neither party to the proposed union is normal, or when the fam-

ilies of both parties are affected with the same disease. As we have seen (p. 175) such instances are by no means rare.

The identical taint is especially apt to be present on both sides when we have to do with the blood-relations. In such cases, therefore, as previously explained (p. 174) especial care must be taken, and the prohibition of marriage will often be essential.

Those who may still hesitate to prohibit marriage in the cases we have been considering should call to mind that there are also social reasons for such a step. On pecuniary and ethical grounds it may seem improbable or even impossible that parents affected with hereditary disease will be able to provide for the proper upbringing of their children. The same considerations apply to those suffering from severe tuberculosis. Although in this disease inheritance in the proper sense of the term does not occur, we cannot expect that tuberculous parents will be able to provide adequately for their children's education, and there also exists a very grave danger of the infection of the offspring with tubercle bacilli (see p. 127). For these reasons sufferers from well-marked tuberculosis should not marry.

What are we to do meanwhile, in the absence of appropriate legislative measures? We must continue to promote the widest possible discussion of the problem and the widest possible diffusion of the conclusions to which that discussion leads. Much would be gained if all about to marry were to ask themselves whether they are justified in taking such a step, and if they would apply for expert advice. The idea must become rooted in the popular consciousness that no one should marry without medical advice. Every one is responsible to his offspring, and he who transmits disease to his descendants acts in a similar way to one who deliberately infects his healthy fellow men with disease, to one who injures them or poisons them. It is necessary that this view should gain ever wider acceptance.

We may then hope that an increasing number of hereditarily diseased individuals will renounce marriage, or that if they are not conscientious and intelligent enough to do this, they will be constrained by their relatives and by the community-at-large. Even if the state is not yet prepared to establish marriage prohibitions for diseased individuals, it should at least give zealous and thorough support to all the means that are adapted to extend our knowledge of heredity in general and of the inheritance of disease in particular, and should instruct all its members concerning the dangers and wrongs that result from the marriage of individuals affected with hereditary disease. On the other hand, the state should favour in every possible way the marriage of healthy individuals and the procreation of children by these. This is a matter wherein the state has a high direct personal interest, for the community is more flourishing in proportion as the number of the sick is small and the number of the healthy large.

If it be the duty of the state to care for the well being of its members, it will incur blame should it fail to do everything in its power to restrict the procreation of diseased children.

CHAPTER X

HOW SHALL WE COME TO TERMS WITH DISEASE?

In all our activities we are continually subjected to the influence of disease, either because we are ourselves the sufferers, or because our fellows are affected, and we are thereby, as previously shown, indirectly implicated in one way or another. The injury inflicted on our race by disease is inconceivably great. It interferes enormously with human evolution. Better times than our own, times in which civilisation will attain to higher levels, and in which all will participate in its advantages, can arrive only when disease has disappeared, or has at least been greatly restricted in extent. From such a future we are still far removed. We learned in the previous chapter that in the prevention of individual diseases some successes have already been gained. But on the whole little has yet been done, and as far as the prevention of hereditary morbid conditions is concerned we stand at the very beginning of our task. It is only by gradual progress that we can hope to attain useful results in this direction, through a clear insight and energetic good-will on the part of all, or at any rate on the part of all persons of influence. At present these conditions are unfulfilled, and even were it otherwise we could not count upon making conspicuous progress within any reasonable time. Consequently, our race will continue for a long period to suffer from disease, and untold future generations will have to reckon with it.

Can we hope that there will ever be any change in this respect? Are we justified in believing that in some remote epoch of human history—so remote as to seem of little

practical concern—disease will altogether disappear? Is not illness a necessary and inseparable accompaniment of the evolution of the whole organic world? The question was discussed in the eighth chapter, but must here be reconsidered in somewhat fuller detail, and in part from a different outlook.

Let us start from the idea of evolution. In the case of living organisms this involves the gradual transformation from the most simple to the most complex types, and involves therewith a progress to higher forms, in accompaniment with the continued development of the mental faculties. Evolution, however, also signifies the formation of the worlds in which organisms live; it signifies further the destruction of worlds and of living beings and the transition to other forms. Evolution is thus the continuous process of transformation undergone by all the constituents of the universe. Form succeeds form, one ever replacing another, in accordance with unalterable rules and in unending succession. Thus the universe is a whole in a state of unceasing flux, and everything that arises does so as the outcome of pre-existing conditions. The universe is the sum of an infinite total of possibilities, possibilities which realise themselves in the process of evolution, disappearing in one place to reappear in another.

According to this view, the world is not a chaos in which form came into existence out of a formless fermenting substance, but rather an unceasing succession of processes, a persistent change of forms, associated each with the others by an inner harmony. The world is not a chaos but a cosmos.

Of this unceasing formative process the evolution of living organisms upon our earth (or in other worlds than ours) constitutes no more than a tiny fraction. Yet this process is the field of operation of innumerable possibilities. The multiplicity of successive and contiguous forms is inconceivably great, but the transformations of all these do not proceed in mutual independence for they are

closely inter-related. One form is determined by another, and by the rest of the environment. This mutual dependence is not merely one of the conditions of the typical process of evolution, inasmuch as in the development of new forms there occurs an adaptation to other forms and to the remaining conditions of existence; it is a condition also for the origination of diseases. For if the adaptation to far-reaching demands prove insufficient, whether these demands proceed from non-living factors of the environment, or from other organisms which conflict with those whose development is newly proceeding, it results that the living organisms that have proved incompetent to undergo adaptation become diseased and perish. Thus disease is a necessary accompaniment of evolution.

How does this view harmonise with the idea of the cosmos? If disease exists within this cosmos, can we regard it as a whole which evolves always harmoniously and in accordance with law? At first sight this would seem impossible, but as we attain to a fuller insight the apparent contradiction disappears.

It is evident that disease does not involve any interruption of the regular succession of natural phenomena in accordance with invariable law. Morbid processes are just as plainly subject to law as are normal. When a noxious influence affects our body, the consequences of its action are necessary in exactly the same way as is necessary, under ordinary conditions, the succession of any phenomenon to another. To the world-all it is a matter of perfect indifference whether in our view a process is morbid or normal.

In ourselves, subject as we are to narrow limitations, disease ensues when changes are induced in our organs. The organs have functions indispensable to our well-being, and these functions cannot be disturbed except to our detriment. But we, who are thus made ill, have no functions in relation to the world-all, we yield it nothing. Whether we are ill or well is a matter of importance to us,

but not to the cosmos, whose evolution is nowise hindered by the fact that our functional activity is depressed, that our value is diminished, or that we perish from disease.

It follows that the existence of disease does not involve any contradiction with our idea of the cosmos, even though we are compelled to regard disease as necessarily associated with the evolution of the organic world. It is possible, however, on the ground of this necessary association, to raise another objection. It may be said that the admission that the association is necessary involves the further admission that our endeavours to abolish disease must be vain, for how can we abolish what is necessary? Morbid conditions must continue so long as organic evolution proceeds. Is this conclusion justified? No, for disease is a regular and necessary accompaniment of the evolutionary process only in the case of those organisms that are not empowered by rational thought to modify the conditions of their own evolution. Man is able deliberately to regulate the struggle for existence, and to diminish or overcome his dependence upon environmental conditions. Thus, from a theoretical point of view we may conclude that he will ultimately be able to counteract the noxious influences that cause disease, and thus to abolish it. It is true that he will only be able to effect this very gradually, and that the end will be completely attained, if ever, in an extremely remote future. Yet such must always be man's goal. Not until our race is freed from disease will it become competent for its highest evolution.

The measures men adopt in their attempts to abolish disease are not matters of arbitrary choice. As we have previously explained, the struggle with pathological states is a necessary product of human evolution. By an inward impulse man is forced to fight against disease. This reaction on his part is just as necessary as has been the origination of disease as an outcome of evolutionary conditions. Very slowly, however, will this necessary struggle prove successful.

For a long time to come we shall have to reckon with the existence of diseases, and the question therefore arises, how we are to come to terms with them until that remote day dawns when we may hope for their abolition. Would it give us adequate satisfaction if, through our energetic campaign against disease, though we should gain very little for ourselves, we might perhaps secure more favourable conditions for later generations? This question must certainly be answered in the negative. It may interest us theoretically to know how our offspring in distant times will fare as regards health, but such knowledge cannot help us through our own troubles. Speaking generally it may be said that it is useless to attempt to console those who are unhappy in the present by assuring them that their offspring will some day be happier. However much we may discuss the possibility of human advance towards a higher and better civilisation, however certain such an advance may appear, no one to-day will for this reason be rendered in the least happier than he is. The first demand of human beings is to be satisfied with the conditions of their personal existence. They think always of themselves first, then of their near relatives, then of more distant kin, then of acquaintances, of their other associates, of their fellow-countrymen. The state of civilisation to be attained by remote posterity is of merely theoretical interest, and its contemplation can exercise but little influence on those now alive.

In these circumstances we have to ask how we may best come to terms with the diseases that now exist. This is the crux of the problem. We are not yet able to abolish them, so how can we live with them? Is it possible for us, disease notwithstanding, so to arrange our lives as to find full satisfaction? What steps can we take towards this goal? Our first aim will naturally be an endeavour to ensure that the curable diseases shall run a favourable course. Next we must try to mitigate as far as possible the consequences of illness. In this respect much can al-

ready be done. By appropriate medical measures we lessen the bodily troubles which are the sequels of diseases that have been but imperfectly cured; persons permanently invalided by illness, if they lack private means, are cared for in infirmaries and asylums; through social legislation, such as the system of national insurance, we take steps to provide compensation for those who have been partially or wholly incapacitated for work. Thus suffering is avoided which in former times was inevitable. Yet there still remains much poverty dependent upon mental or physical incapacity for work—poverty which, though preventable, is not prevented by the measures now in force. To provide more adequate help in this respect is the duty of the state and of the community at large.

Apart from these measures, we must take steps to obviate the consequences entailed by disease in the religious domain, consequences which find expression in that dogmatic intolerance whose disadvantageous influence upon the course of human evolution it is hardly possible to overestimate. This intolerance, which exists solely because of disease, must be restrained by all the means in our power. But the task is not an easy one. Dogma being essentially intolerant, intolerant also are an extraordinarily large proportion of its adherents. It is difficult or impossible to convince the dogmatist that other views than his own have also a right to exist. Yet it is precisely the dogmatist who should be accessible to such an idea. For those whose dispositions are truly religious feel that their views spring from their own inner natures, and they ought to be willing to admit that the ideas of others well up with the like irresistible force from within—and that others, like themselves cleave to their own views from profound conviction, and cannot do otherwise. Few adherents of dogma, however, are capable of recognising this, and hence the suppression of intolerance is as difficult as it is indispensable. Even to-day, notwithstanding the existence of disease, life would be far more satisfactory and much happier if every

one were willing to allow every one else to be happy after his own fashion.

To do away with the consequences of disease is a merely negative task. A matter of far greater importance is for men to search for that which is healthy in themselves and their fellows, and to foster this in every possible way—to seek the healthy, which is alone worth while, which corresponds to his innermost sentiments, which he greets wherever he finds it. Disease, on the other hand, which men instinctively dislike, which they regard as disagreeable, antipathetic, and uncanny, must not be allowed to gain a wider sphere of influence than it possesses to-day. On the contrary, disease must be repressed. Man must learn to recognise clearly that disease is not a permanent and essential part of his nature, that morbidity, however closely it attaches to the individual and unfits him for functional activity, is merely imposed upon the race as a whole, and therefore of course upon the individual, by certain external conditions, is no more than an accidental attribute. We could conceive disease as non-existent without mankind's thereby suffering any loss. The *idea* of humanity, if we may use this term to make our meaning clear, traverses the whole of its evolution, unchanged by disease, although assuredly progress is hindered by the existence of disease. The idea of humanity connotes also the idea of health. All that exists in the individual in the way of normal elements, apart from disease and abnormality of constitution, is summed up in the human race as a whole to form the concept of the healthy human being, of one whose development is all-sided, harmonious in body and in mind, and harmonious also in functional activity. Not thus do we know man to-day, but thus we imagine him in the remote future. With Nietzsche we hope for the coming of more highly evolved human beings. What Neitzsche speaks of as the superman is in our sense the healthy human being in the plenitude of his powers, all of whose faculties are developed to the full, who no longer knows

anything of sympathy merely because there no longer exists anything to arouse it, and who is beyond good and evil because there will no longer be any place for these ideas as now understood. Evil is merely the outcome of man's morbid state. The healthy human being knows nothing of evil because he is capable of no other actions than those that are good, that is to say, in harmony with the aims of human evolution. To-day, indeed, man knows evil, but only because he sees it in diseased and abnormal individuals. If at some future date disease should cease to exist, there will no longer be any evil.

Man's desires are therefore set upon the attainment of this state of perfect health. It is one at which he cannot hope to arrive for long ages yet to come, and his longing for it cannot now be appeased. At present, and until the aims of racial hygiene are fulfilled, diseases must continue to prevail, with all their destructive consequences. Thus the only choice open to us is to oppose disease to the best of our ability, to foster health and develop it to the utmost of our powers. We must take steps to secure that disease shall not thrust itself into the foreground and determine our views of life. Regarding it as something foreign to our nature, we must always and everywhere repress its manifestations.

The man whose thoughts are healthy must discover the healthy sides of his own individuality, must cultivate and favour these, and thus make the content of his existence as rich as possible. For this the various sides of his ego provide him with manifold and fruitful opportunities. According to the nature of his tendencies he can develop one or all of these, and allow those of them to gain dominion whereby the morbid elements will be repressed, and will no longer exercise a determinative influence upon the content of existence.

Among the healthy activities of our race the most important is the pursuit of knowledge, which finds expression in our scientific work considered as a whole. Little by little,

man unveils the secrets of nature, and the smallest gain in this direction secures for him the highest and purest pleasure. Even those who, although they do not themselves actively participate in this work, are privileged to share an understanding of its results, gain thereby the greatest satisfaction. It is not, however, the small and individual results which especially please us. The full value of these separate items depends upon the fact that they serve for the foundation of general ideas, affording fresh means for the interpretation of the great interconnexions of things, a fuller understanding of the relationship of humanity to the universe. All the detailed progress effected in any particular science, be it natural science or history, be it linguistic science or medicine, acquires its full significance only when it enhances our insight into the universe. This is the knowledge we so ardently desire. By means of such knowledge we draw nearer to the great whole, we feel more and more that we belong to that whole, that we are parts of the infinitely great. We thus derive a profound inward satisfaction.

In this insight there is contained a well-marked religious factor. For religion really signifies nothing more than the feeling of our affinity to the universe, and not, as it has sometimes been defined, the feeling of dependence, which can never have a religious character. Dependence arouses embarrassment, discomfort, envy, dread, and hatred. The dependent feels depressed, and never rejoiced, by his condition. Affinity, on the other hand, arouses confidence, a sense of security and elevation. The feeling that we belong to a family, to a nation, to a state, makes us happy and proud. This feeling gives to the individual a sense of being protected. The man who seeks inward peace takes refuge with his own, with those to whom he belongs. When the believer honours God as his father, and feels himself to be God's child, what does this signify other than his conviction that he belongs to God! It is true that the feeling is here also associated with one of dependence, but

this latter does not constitute the essence of the idea of the filial relationship, which can arise only out of a sense of affinity. The child feels secure in the family, only because it is of one nature with its parents, because it belongs to them.

The scientific thinker's sense of affinity to the universe thus contains a religious element, which can find pure expression only in the healthy individual, or, to word it better, only in a healthy humanity. He knows that he derives from the cosmos, and that into this he will merge once more, to be taken up afresh into the unending course of evolution. This is a religious idea, but it is one in which mankind will not find complete satisfaction until the members of our race are all perfectly healthy, until their lives are therefore perfectly happy, and until death comes solely through the gradual onset of old age.

The acquirement of knowledge is therefore the most important means by which we are enabled to oppose morbid conditions, to forget them, or to render them less perceptible. An additional help, however, is derivable from the pure enjoyment of the unspeakable beauties which the world offers to our contemplation. The beauties of nature affect man profoundly. He merges himself in these beauties, feels akin to them, sees in all that lives and all that exists an image of his own being, just as in himself he sees an image of the whole. It is only because he has assurance of this essential identity that he is able to merge himself wholly in nature and to give himself up unreservedly to its enjoyment. The infinitely little and the inconceivably great, the inorganic crystal as well as all the vital processes of the organic world, the organisation of plants and of animals, the art-forms of nature (as Haeckel terms them)—all these things afford ever-renewed sources of delight. But man must be receptive for these beauties and this he can be to the full only when he is healthy, or at least when he can make himself independent of disease. The majority of invalids, those who are mentally abnormal,

those whose development is one-sided, pass by the beauties of nature without regarding or comprehending them. A general and joyful appreciation of nature will become possible solely through the disappearance of disease.

Happiness is derived also from the beauties of art. How profound the inner satisfaction, how complete the liberation from the pressing cares of everyday life, afforded by the appreciation of music, poetry, painting, and sculpture —to this countless healthy human beings can bear witness. We forget the surrounding world, we experience the dominance of beauty, and are rejoiced. But for this to be possible there must also exist a suitable capacity, a receptive faculty. Many invalids and abnormal human beings are unable to find pleasure in any branch of art. Here improvement can be effected only by the general diffusion of health. Then the joys of æsthetic pleasure will become more widely disseminated, those joys which all that finds expression in art yields to the most intimate nature of man.

A manifold source of satisfaction is also found by human beings in the process of absorption into the lives of their healthy fellows. The example of great men, healthy in their greatness, is elevating, and to follow the mental life of leading individuals in their spoken or printed experiences may be a source of the highest pleasure. To become acquainted with a significant human being, one harmoniously self-sufficient, functionally capable, embracing humanity and the universe in his comprehensive thought, may furnish enduring happiness.

We think here not only of our contemporaries. The great and healthy individualities of the past, those of an earlier epoch however remote, may liberate our spirits and enable us to forget our morbid condition. The historical evolution of our race affects us in the same way. We feel it to be something beautiful and great to merge ourselves in imagination in the being and the activities of earlier generations and in all the healthy results that human effort has effected in every domain. The meaning of humanity is

found only in humanity as a whole. One who confines his attention to the life of to-day learns but a small fragment. For this reason, the study of history is one of the most important occupations of healthy humanity.

The reflective man gains satisfaction, not merely when he prepares for his fellows the pleasures of knowledge, nature, and art, but also, and often to a greater extent, when he reveals these pleasures to others. Healthy and healthy-minded human beings feel that they are inter-related, that they belong to one another, that they are members of a greater whole. As Kropotkin has shown in his instructive work on *Mutual Aid,* the lower animals of the same species hold together and give one another mutual support. Healthy human beings do the same, whereas those who are diseased, dogmatists, one-sided persons, egoists, and jingoes, make war upon one another. The individual knows that he cannot permanently live for himself alone. Mutual aid is essential to the success of individuals no less than to that of humanity as a whole. The happiness of one is incomplete without the happiness of all. How can any one feel well when he has to witness the suffering of his near associates or of his fellow-countrymen? None but the egoist can be satisfied under such conditions. To him it matters not if others be ill, so long as he is well. But egoism is one-sidedness, is an anomaly, is morbid. The healthy individual is interested in his family, in his friends, in his country, and is ready to sacrifice himself for these.

Out of this feeling of the mutual affinity of human beings there arises the care for others' weal, altruism, social activity. To render help to others is a source of purest joy to all whose sentiments are not distorted by disease or other abnormality. The necessity of social effort will, however, certainly diminish in proportion as mankind becomes more healthy, for this necessity depends solely upon the fact that most human beings are abnormal, being in part diseased in the narrower sense of the term, and in part below par-value, and ill adapted for the struggle for existence. In

a healthy human race, altruistic activity would no longer be essential.

To-day, however, the need for altruism exists. It must be our aim, not only to diminish the outward and physical suffering of others, but also to awaken, to cultivate, and to develop all that in them is mentally healthy. One of the principal duties of healthy men is to allow others to share to the extent that their understandings permit in all that they themselves effect or are interested in in science, natural knowledge, and art.

Those whose mental values are defective, and above all those whose powers and opportunities have been restricted by poverty, must receive their share in the mental treasures of healthy humanity, which alone bring true happiness. A great injustice is committed if no steps are taken to secure for those who have to earn their daily bread by arduous labour some share of that which is offered to others in abundance, some of the happiness which art and science can yield. People complain of the roughness, the laziness, and the lack of interest of the industrial and agricultural workers, and deplore the ravages of alcoholism. But such complaints lack justification if no opportunity is provided for human beings to employ their good qualities and to strengthen these by exercise, while repressing their undesirable tendencies. We shall succeed very imperfectly in freeing people from the scourge of alcoholism by endeavouring to instruct them as to the dangers of alcohol. They lack the insight necessary to understand these dangers, and this insight can develop only as their condition becomes more healthy. In the weaning of men from alcohol we cannot expect to attain to satisfactory results, unless we provide for them a liberation from the cares and burdens of every-day life—a liberation they now seek and find in alcohol—by providing them with intellectual enjoyments. Nor can we cure their roughness in any other way than this. It is true that we must not nourish exaggerated hopes. Alcoholism and roughness are for the most part the

outcome of a morbid mental constitution, and will disappear with this constitution in subsequent generations, when we succeed in effecting the sanation of our race. Still, we may always hope that by such measures as are here suggested we shall strengthen and cultivate the healthy mental sides of those to whom they are applied, and that not infrequently in such cases the healthy will get the upper hand of the morbid.

In such cares for the mental culture of his fellows the reflective man finds a further source of profound satisfaction which will assist him to ignore disease in himself and in others.

Another important point has to be considered. No one can be equally active in all directions at once. Most individuals are more highly gifted in some particular sphere. This indicates to us a very important task, namely, to develop to the full the special gift, while avoiding the production of an injurious one-sidedness—to cultivate to the utmost the special faculty, whatever it may be, scientific, artistic, or social. Any one who feels at home in any particular domain, who in this domain can excel or can at any rate effect much, will derive especial pleasure from the exercise of this pre-eminent faculty, and even if he be ailing will be lifted by such exercise above his personal troubles. Not until each individual can develop his peculiar talents to the full, can humanity as a whole advance as it should. One of the most important aims of education, as Ostwald has shown, is to favour the growth of individuality, to recognise greatness early, and to cultivate it.

Thus for the reflective man there exist numerous possibilities aided by which he will rise superior to the existence of diseases, notwithstanding the enormous amount of injury these inflict upon mankind. Inasmuch as he is convinced that disease is a force hostile to his nature, he will strive to attain perfect health, and will hope that our race as a whole will some day acquire this also, though in a remote future. But as long as disease continues to exist,

he must do his best to counteract the consequences entailed by disease in the physical and mental sphere, must cultivate and develop the healthy elements which exist in individuals in varying degree, and as the outcome of these endeavours must gain the energy that will enable him to thrust into the background those disquieting and painful hindrances to life which are now dependent upon the existence of disease.

Health remains the desire and the goal of humanity. In the desire for health all other desires are comprised; in the attainment of health the satisfaction of all other desires is promised. The healthy man is in harmony with his own being, in harmony with the healthy human race, and in harmony with the universe. Health is happiness, the great happiness for which man yearns. If, as we are often assured, the aim of humanity must be to secure the greatest good of the greatest number, this good will certainly be attained with the attainment of general health. This is the end of every man's desire.

THE END


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